Verhandlungen der **Gesellschaft für Ökologie** - Band 42

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GfÖ 2012

From Basic Ecology to the Challenges of Modern Society

LEUPHANA
UNIVERSITÄT LÜNEBURG

ISSN 0171-1113

ECOLOGICAL SOCIETY OF GERMANY, AUSTRIA AND SWITZERLAND

42nd Annual Meeting

"From Basic Ecology to the Challenges of Modern Society"

GfÖ 2012

Leuphana University Lüneburg
10th – 14th September 2012

Book of Abstracts

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Verhandlungen der Gesellschaft für Ökologie, Band 42, ISSN 0171-1113

Herausgegeben im Auftrag der Gesellschaft für Ökologie von

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The 42nd Annual Conference of the Ecological Society of Germany, Austria and Switzerland (GfÖ) is taking place from 10th to 14th of September 2012 at the Leuphana University Lüneburg. Host of the Conference is the Institute of Ecology.

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Print: Druckerei Görich & Weiershäuser, D-35037 Marburg

Dear friends and colleagues,

I warmly welcome you to the 42th Annual Meeting of the Ecological Society of Germany, Austria & Switzerland (GfÖ) in the Hanseatic City of Lüneburg. First mentioned in 956 A.D., Lüneburg today combines its unique medieval charm with the lively atmosphere of an aspiring town located in the Hamburg Metropolitan Region. The newly founded Leuphana University has become a major factor driving this development. It sees itself as a humanistic university that places knowledge acquirement into concrete contexts, a sustainable university that takes responsibility for shaping the future in a sustainable manner, and a proactive university that creatively contributes to the progress of the society, respectively. This mission obviously fits very well to the major targets of the GfÖ. The Leuphana University of Lüneburg is thus a perfect place for ecologists from all around the world to assemble for discussing the most recent challenges to our exciting discipline, for identifying new routes to scientific solutions, or – as trivial it may sound – simply for meeting people of similar interest.

A close look at the programme shows that the organizers have successfully managed to set the perfect floor for a scientific meeting that lives up to all the expectations mentioned above. They also succeeded in elegantly merging the many applied disciplines of ecology with very ambitious methodological and theoretical questions. I am very grateful to all of them for making this conference possible.

I wish us a productive and communicative meeting in the friendly and stimulating atmosphere of Lüneburg.

Volkmar Wolters

President of the GfÖ

KEYNOTES

K1 – How interaction networks help to understand ecosystem functioning and stability

Nico Blüthgen[1]

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Species interaction networks and food webs have become a prominent topic in community ecology. Recent advances in empirical data and network analysis and an increased sampling of have improved our understanding of underlying biological processes. We are currently moving towards more realistic predictions about ecosystem consequences - the amplitude and stability of ecosystem functions performed by the species in the network.

Functional 'redundancy' (FR), a high diversity of species performing the same function, represents an insurance of a system against disturbances. FR thus improves the overall functional stability. For each function displayed by the network, higher FR may derive from (1) higher population densities, (2) higher overall diversity and (3) higher generalisation of the functional performers. We show that all three factors may be involved to explain losses in FR following ecosystem disturbance by land use. If losses in FR translate into a more narrow tolerance of environmental stress (lower 'response diversity'), the synergistic effect of habitat degradation and climate change represents a serious threat for ecosystem functioning in the future.

Whereas FR secures ecosystem functioning over time, the species' functional complementarity (FC) at different scales improves the actual functional performance level. Only by higher diversity, both FR and FC can be enhanced at the same time, where specialists are particularly important but also most vulnerable.

I will illustrate these relevant issues with recent studies on plant-pollinator and plant-frugivore interactions. For example, different pollinator species may contribute to pollination of a target plant population. The more species are involved, the higher the FR that may buffer this service against population declines or local extinctions in some of the performing species. Higher FR may go along with higher response diversity, increasing the likelihood that at least some of the species tolerate climatic extremes or other environmental stresses. In addition, pollinator species may also serve different parts of the plant or during different times and conditions - an example for subtle, but important FC to a plant individual or population. Both FR and FC are assumed to decrease with declining biodiversity. Losses in FR represent qualitative risks and losses in FC quantitative risks for the maintenance of ecosystem functioning.

K2 – Innovations in Science and Policy for Harmonizing People and Nature

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Around the world, leaders are recognizing ecosystems as natural capital assets that supply life-support services of tremendous value. The challenge is to turn this recognition into incentives and institutions that will guide wise investments in natural capital, on a large scale. Gretchen Daily will discuss pioneering advances being made on three key fronts. The first is in quantifying the conservation value of agricultural landscapes for biodiversity, ecosystem functioning, and ecosystem services. The second is the development of new science and technical tools for valuing Nature, such as InVEST, an open-source software system under development by many partners of the Natural Capital Project, for Integrated Valuation of Ecosystem Services and Tradeoffs. And the third is new policies and finance mechanisms being implemented worldwide, with examples from China, South America, and the United States. Taken together, there is tremendous need for strengthening science and policy, but also promise for forging a deep and lasting transformation that harmonizes people and Nature.

K3 – Of Bats and Rats: Interplay Between Primary and Secondary Seed Dispersers of Small- and Large-Seeded Plants in Tropical Rainforests

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Together, Chiroptera and Rodentia account for 58% of all mammalian species. Bats and flying foxes evolved originally as insectivores, but now they have the largest dietary diversity among mammals. The Chiroptera encompasses several frugivore species in both the New and Old Worlds, which play key roles in the seed dispersal process. In primates, the plant-eating diet evolved from the carnivore ancestors. Rodents are omnivores, insectivores, herbivores or frugivores-granivores. About 40 years ago, studies on seed dispersal by frugivores (zoochory) have been pioneered by biologists studying the biology of primates, birds, and bats in the tropics. Though the role of fruit-eating rodents as dispersers of large seeds was early acknowledged, it is relatively late that their important role as scatterhoarders of seeds dispersed by other vectors has been pointed out. In the past two decades, ecological research on diplochory (sensu Vander Wall & Longland, 2004) has been established as a solid research topic. Indeed, it is commonly accepted today that both small- and large-seeded plants depend on the interplay between primary and secondary seed dispersers for their survival and establishment. This is particularly true in tropical habitats, where a diverse coterie of flying, arboreal, and terrestrial frugivores consume fruit and defecate or drop seeds underneath roosts or in latrines, which are then harvested by terrestrial invertebrates and vertebrates. On the one hand, when the fruit is small enough to be swallowed and transported, seeds are either spat or defecated (endozoochory). On the other hand, when the fruit is too large, it is carried away in the mouth and released after the pulp is consumed (stomatochory, sensu Lobova et al. 2009). Bats may disperse minute to large seeds ranging from one millimeter to tens of centimeters in length or diameter; the overlap with birds and non-flying frugivores is low. Nonetheless, among round to elongated large (average 20-25 mm in length) seeds, many are also harvested, eaten or cached by rodents, the smaller ones (average 2 mm in length) being removed either by ants or dung beetles. In this presentation, we will review the literature on how bats share the seed dispersal process with secondary dispersers, especially rodents, presenting several examples of this interplay in Central and South American, as well as in Central African, rainforests. We will particularly emphasize and document the effect of seed size on the type of primary dispersal by frugivores and granivores, showing that there is a threshold for this interaction. Moreover, the interaction is complemented by other vertebrates and invertebrates, i.e. ants and dung beetles, which are able to remove small seeds that are not carried by rodents interested mainly in the large ones. These relationships between plants and animals will be assessed as an interaction network assembling all communities, in order to test for guild structure and sharing of dispersal services among different vector groups. The network approach will allow us also to identify which species are most important for maintaining the seed dispersal service in the Neotropics.

K4 – Conservation-development trade-offs and the challenge of translating conservation science into policy: some insights from the Brazilian Amazon

Toby Gardner[1]

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Rural development across the tropics usually translates into a non-sustainable pathway from the conversion of native forests to subsequent land-use intensification and impairment of vital ecosystem services. The same types of land-use change that took centuries to occur in other parts of the world are typically being played out over the scale of years or decades in many tropical nations. The Brazilian Amazon, encompassing some 40% of the world's remaining tropical forests and a rapidly expanding population of at least 20 million people, is a prominent example.

Tackling this problem requires a deep understanding of the changing relationships amongst different actors and institutions combined with the ways in which different land-uses impact the environment and the provision of key ecosystem services. Here we present the conceptual framework and methodological basis of the Sustainable Amazon Network (RAS); a network of more than 30 research, civil society and local government organizations working to assess the nature and strength of trade-offs between development activities and environmental conservation in the eastern Brazilian Amazon.

The rationale underpinning RAS is to decompose some of the complexity that characterises variability in rural development pathways, including both socioeconomic (e.g. institutional, political, and market aspects) and biophysical components (e.g. ecological condition and resilience as measured by ecosystem service stocks and patterns of native biodiversity). This assessment process can then be used to test and validate assumptions and scenarios relating to the social-ecological costs and benefits that are associated with different land-use and management options at local, landscape and regional scales.

RAS presents two unique strategic advantages for assessing sustainability. First, work is conducted at spatial scales that are large enough to encompass major gradients of anthropogenic disturbance while also resonating with multiple scales of management. Second, we have collected standardised and spatially comparable data across all study farms on patterns of biodiversity value, ecosystem service production (carbon storage and soil conservation), and socio-economic condition (agricultural productivity, income generation, and subjective measures of well-being).

Working across multiple scales of management allows insights into the relative importance of different drivers and constraints, as well as the relative benefits and potential of individual versus collective action interventions to deliver improvements in land-use sustainability. To address these issues our research approach is divided into two overlapping stages: (i) a detailed problem analysis to clarify and describe changing patterns of land-value across different management systems, as well as to quantify trade-offs and synergies between environmental and socio-economic dimensions, and (ii) an evaluation of possible approaches to delivering more sustainable development trajectories.

Here I will present initial project results regarding both the ecological and social systems. These include; (i) powerful evidence for the importance of landscape scale changes in forest cover and forest degradation in driving the changes in forest biodiversity and ecosystem service provision - illustrating the need for both coordinated farm management and avoided degradation from fire and repeated logging to safeguard ecological resilience in human-modified systems, (ii) complex relationships between patterns of carbon and biodiversity with the strength of correlations being dependent on the spatial scale of comparison and level of forest degradation, providing important guidance for the development of effective biodiversity conservation programmes, and (iii) marked spatial and temporal variability in wealth and human capital amongst different groups of rural producers, highlighting the need for carefully tailored conservation and development strategies in multiple-use and rapidly changing landscapes such as those which dominant deforestation frontiers across the world.

K5 – Consequences of climate change on marine biodiversity, ecosystem functioning, and resilience

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More than two thirds of earth surface is covered by the oceans comprising a large diversity of habitats and species. The vast majority of species especially from the deep sea, however, still remains undescribed. Modern estimates attribute half of global primary production to marine phytoplankton which affects abundance, diversity and ecosystem functioning on all trophic levels and strongly influences biogeochemical cycles. Especially planktonic primary producing calcifers are important driving the biological carbon pump. Coastal primary producers such as seagrass and macroalgae are essential builders for nursery habitats of commercial fish and function as nutrient storage and purification system in often nutrient loaded near-shore waters. As in all ecosystems worldwide marine biodiversity unprecedentedly declines since industrial revolution. Global change is one of the most important drivers for marine biodiversity loss. Among other consequences of anthropogenic CO2 emissions the future ocean is expected to become warmer and acidified. It has been shown that global marine biodiversity distribution is strongly temperature driven per se, pointing to the fact that future rising temperatures combined with other stressors will lead to unexpected and severe consequences in terms of species loss and ecosystem functioning.

Local experimental studies and global meta-analyses suggest that marine biodiversity and productivity will further decline in response to rising temperature. Dominance in coastal benthic primary producer communities shifted towards a temperature tolerant but lower yielding species after a realistically simulated heat-wave. Along with lower primary production in this system bacterial abundance increased which suggest nutrient draw down into the microbial loop and thus an additional source for altered competitive interactions for inorganic nutrients. In multi-trophic experiments moderate temperature increase enhanced top-down control and ultimately decreased producer diversity. In the open ocean as a consequence of rising temperature nutrient availability is expected to decline by reducing mixing depth and thereby alter phytoplankton diversity and biomass production. A first summarizing meta-analysis on experimental temperature manipulation suggests an average marine species loss of 14% for projected mean future temperature.

Research on the consequences of ocean acidification for marine biodiversity and ecosystem functioning is still in its early stage. Nonetheless, it has become clear that especially calcifying organisms are strongly physiologically affected. At the same time total biomass and calcification during a calcifying phytoplankton bloom strongly depend on the initial community architecture. This leads to the still open question of assessing the relative strength of biodiversity effects compared to direct effects of global change on ecosystem functioning.

Only a small part of the large number of studies experimentally manipulating biodiversity has been conducted in marine systems. Important findings were that non-random species loss reveals stronger consequences for ecosystem function compared to random manipulation, and that species loss on one trophic level affects functioning on another. Moreover, diversity effects are scale dependent. Due to environmental heterogeneity in metacommunity experiments diversity effects occurred on the regional but not on local scale. First experimental results also show that systems with more evenly distributed species have higher capacities to adapt to changing environmental conditions. That is, the absence of a strong general competitor enables a community to quickly recover and compensate the loss of a functionally important species. This finding highlights the potential critical situation of slow growing monodominant coastal habitat builders such as seagrass and kelp and points to the importance of genotypic diversity as a potential insurance adapting to changing environment.

K6 – Bundles of ecosystem services in social-ecological systems

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We now live in the Anthropocene - an era in which human action dominates the earth system. Consequently, most ecosystem system services are produced in human dominated ecosystems where the structure and functioning of the ecosystem are significantly shaped by both human ecological engineering and the unintended consequences of human activity. How does considering this social-ecological context change how we analyze ecosystem services? I argue that ecosystem service analysis can be simplified by considered the social-ecological rather than merely the social. I use research on multiple ecosystem services in an agricultural landscape in Canada to show how social, geographic, and ecological factors combine to produce ecosystem services and how these factors can be used to predict ecosystem service patterns and dynamics.

A key challenge of ecosystem management is determining how to manage multiple ecosystem services across landscapes. Interactions among ecosystem services occur when multiple services respond to the same driver of change or when inter- actions among the services themselves cause changes in one service to alter the provision of another. Actions to enhance the supply of some ecosystem services, usually provisioning services such a food production, have led to declines in many other ecosystem services, usually regulating and cultural services such as nutrient cycling, flood regulation, and opportunities for recreation.

Ecosystem service tradeoffs arise when the provision of one service is enhanced at the cost of reducing the provision of another service, and ecosystem service synergies arise when multiple services are enhanced simultaneously. Both tradeoffs and synergies can be managed to either reduce their associated costs to society or enhance landscape multi-functionality and net human wellbeing, respectively. For example, nutrient runoff from agriculture can be reduced by minimizing fertilizer use, using conservation tillage, or maintaining riparian zones, each of which can be done without causing substantial declines in food production. At the same time, enhancing one service, such as improving nutrient. The concept of ecosystem service bundles can be used to identify key interactions among ecosystem services.

I show how social-ecological systems can define ecosystem service bundles and how these bundles can be empirically identified common ecosystem service tradeoffs and synergies across a landscape. Because these bundles are produced by the interaction of social, ecological and geographic factors - integrating the social and ecological can lead to simpler ways to predict and estimate ecosystem services than approaches that build up from biological traits.

K7 – Tropical forest biodiversity in the balance

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Recent new analyses have revised estimates of global species richness to around 5-8 million with, for the first time, some measures of the statistical likelihood of higher or lower estimates. At the same time we also have clearer evidence that the majority of these species are from the terrestrial rather than the marine environment, and that most are insects and their close relatives. How these terrestrial species are distributed between forest and non-forested or temperate and tropical ecosystems is still not clear. However most evidence suggests that forests and in particular, tropical forests hold the majority of all species.

The tropical forest canopy was once famously called 'the last biotic frontier', although others who study the deep seas around the Antarctic might challenge this view. Comparisons of the biodiversity associated with the ground and the canopy appear to show that in some ways they are equally rich in species that are indicators of each stratum but, importantly, there appear to be more new species to be found in the canopy than the ground. New evidence from studies using the Australian canopy crane also shows that the insect assemblage associated with flowers appears to be a largely ignored and rich component of the forest fauna.

Inevitably then, the fate of the majority of the world's biodiversity depends largely on the fate of tropical forests. Recent research suggests that retention of primary forest is vital for the conservation and survival of most endemic species and yet more than 50% of the world's forests are now 'secondary forests' of one kind or another. The last three remaining mega blocks of rainforest, the Amazon, Congo and New Guinea forests, are all under increasing threat. With declining areas of tropical forests the fate of a large proportion of tropical forest biodiversity appears to hang in the balance particularly as climate change is working synergistically with other threats. Inevitably, we will see an increased homogenisation of the world's biota. If we cannot agree globally to halt greenhouse gas emissions and land-use change, then can we at least describe most of the 85-90% of unnamed species before they go extinct?

SESSIONS –
ORAL AND POSTER PRESENTATIONS

Session 1 – Bioenergy: Challenge or support for the conservation of farmland biodiversity?

Chairs: Jens Dauber, Andreas Bolte

O1 - Facilitation of bioenergy production increases the risk of failing national targets on land-use sustainability

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One way to achieve a reduction of CO_2 is to use renewable resources for energy production. As a consequence, the production of energy plants has enormously increased in recent years. The biomass of these plants can be used by biogas power plants to produce methane, which can be converted into electricity and heat. In Germany, 79% of the biomass used for this process stems from maize. Over the last ten years the area used for growing maize has increased from 1.5 Mio ha in 2002 to 2.5 Mio ha in 2011 in Germany. We modelled the effect of this dramatic agricultural change on the population size of eight farmland bird species by using (a) 90 000 bird records, (b) a high resolution land-use map based on crop type information of 8.5 Mio fields in Germany and (c) three land-use scenarios on the future expansion of area covered with maize. All bird species included in our study are part of the governmental indicator for the sustainability of land-use in Germany. The sustainability strategy of Germany sets the target of stabilising the status of all species within the species diversity indicator. To date, only 69% of this target has been reached for farmland. The modelling results reveal that only two of the eight farmland indicator species would profit from the facilitation of maize production. Under the condition that the current production of maize would double, the total breeding population of the eight species would decline by about 0.4 Mio pairs. This loss would further diminish the target value of land-use sustainability to 53%. These findings suggest that the aim of increasing land-use sustainability in Germany will not be reachable in case the energy transition largely relies on increasing maize production.

O2 – Negative impacts of increased use of bio-energy crops for three farmland birds can partially be mitigated with spatial management actions

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The current agricultural land-use change where increasingly more arable land is used for bio-energy crops has consequences for wild life. We evaluate these consequences and possible mitigation strategies for three true farmland birds (Skylark; *Alauda arvensis*, Yellow Wagtail; *Motacilla flava* and Cornbunting; *Miliaria calandra*) with a mechanistic simulation model and data-based species-specific habitat preferences. We performed scenario-based simulations and investigated several land-use change aspects in three simulation experiments. The scenarios included "business as usual", "enhanced bioenergy cropping" and the mitigation strategies "maintainance of 10% high nature value (HNV)

farmland", "10% bio-energy crop alfalfa", "increased crop diversity" and "reduced field size". We investigated different aspects of enhanced bio-energy cropping such as the effect of pure crop change (nest and foraging habitat for farmland birds), but also landscape configuration changes such as spatial agglomeration of bio-energy fields, reduced crop diversity and increased field size. Our results indicate that single and moderately applied changes already have a negative effect (decreased number of potential breeding pairs), but that the magnitude of impact differs for different birds. The maintainance of HNV farmland (set-aside and fallow land) and reduction in field size are the best mitigation strategies, the former by providing "safe" habitat and the latter by buffering the risk of food loss within a certain foraging range. We further show that spatial agglomeration of bioenergy and combined aspects enforce the negative effects. To conserve wildlife in bioenergy dominated areas, actions should be taken to mitigate the negative effects.

O3 – A landscape generator prototype and its application as tool for integrated regional environmental impact assessment of bioenergy activities

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Biomass from renewable resources for bioenergy uses offers a great opportunity for the replacement of fossil fuels, especially for future energy demand scenarios. However, modified land use change may lead to new or increased environmental impacts, additionally modulated by climate change. For the assessment of bioenergy impacts on the environment, there is need for regional studies, which integrate a variety of impacts, and which go further than classical Life-cycle-assessments (LCAs), e.g. by including effects on biodiversity, or on river and streams. Especially it is important to include the effects on biodiversity, as such studies are still rare.

To tackle this aims, we present a landscape generator, which aims to understand the environmental impacts of bioenergy use on the environment including future climate change at the landscape level. This approach will include exemplary studies of bioenergy impacts on biodiversity, aspects of spatial effects of the landscape on populations, which are exemplarily shown with an application to an agrarian birds simulation model.

The landscape generator will vary systematically spatial structures of model-landscapes, e.g. landscape configuration and composition, and relative distribution of cropping systems. It generates a set of model-landscapes, which can be investigated consistently by several collaborating projects with specific questions related to the bioenergy impact on the environment. The use of the same model-landscapes for all collaborating projects ensures a consistent multi-criterial impact analysis.

The results of the specific modelling studies will be used for the analysis of the environmental bioenergy impacts at the landscape and the regional scale.

O4 – Integrative concepts at field and farm level as basis of a biodiversity-friendly biogas crop production

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[2]Georg-August-Universitaet Goettingen, Interdisziplinaeres Zentrum fuer Nachhaltige Entwicklung, Goettingen, DE

The rapid expansion of biomass use for energy production is accompanied by significant effects on land use systems. In regions with high livestock density and in the immediate vicinity of biogas plants it often results in tight crop rotation and the loss of landscape structure. Even in intensively used agricultural landscapes both can lead in a further decrease in habitat quality and biodiversity. On the other hand, the provision of biomass for biogas production has high potential for increasing crop rotation and structural diversity, but is now rarely used. At the field level the vision of “integrative energy cultivation concepts” (IECC) is to contribute to a more diverse and sustainable rural landscape. IECCs should harmonize utilization/production and protection of landscape and nature. In model farms in lower Saxony IECCs were tested, using manifold winter and summer annuals, perennials and wild herbs in pure culture, mixed culture and as nurse crops in cultivation. The ecological challenges regarding the current cultivation concepts are described and farm specific examples for more sustainable concepts for biogas production are given. At the landscape level among others the creation of new and the improvement of existing field boundaries and the creation of flowering, fallow and arable weed strips enhance structural diversity and habitat qualities resulting in higher biodiversity and in an increased biotope networking. The implementation of appropriate measures within the framework of an integrated approach at the farm level supports their effectiveness. The combination of the IECC at the field level and of integrated concepts for landscape development at the farm level creates favorable conditions for protecting and enhancing the biodiversity of agricultural landscapes used for bioenergy production.

O5 – Designing crop rotations as key issue for improving the bioenergy impacts on farmland biodiversity

Michael Glemnitz[1], Ralph Platen[1]

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Current public discussion on the challenges of bioenergy cropping is limited to very few aspects of the farming system: to the ploughing up of grassland and to the increase of maize cropping. Biomass production on arable creates very complex modifications, including new options and implies the strongest modifications in regional land use since decades. The land management change at the local scale. Since farmland biodiversity is adapted to spatial and temporal interactions with the surrounding landscape and neighboring or subsequent crops, limitations in the temporal/spatial exchange are the main challenge for farmland biodiversity.
Based on field investigations of the habitat quality of different crops and a simple data based crop habitat model, we want to show up the impact of single crops, key parameters for wildlife support in crop rotations as well as the impact of different crop rotations at varying natural frame conditions exemplarily for five different organism groups (weeds, arthropods, spiders, pollinators and farmland birds). From the results of our field and plot trials, we can consider that structural diversity within crop

rotations will support species diversity over time, but specific organism groups or single target species will be promoted only by single, specific crop traits. Due to varying local species inventories and growing conditions, the effects of crop rotations may also vary between regions for specific biodiversity targets. These findings finally illustrate the need for regionalized targets for farmland biodiversity. Based on the knowledge about crop traits and their effects on specific organism groups, we provide some suggestions for biodiversity-friendly crop rotations, which are combining high biomass yields with positive effects on specific target groups (farmland birds, pollinators).

O6 – Activity biomass of ground beetles (Col.: Carabidae) in maize and sorghum fields

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The average individual biomass of a population may be used as an indicator for the relative fitness of a population because it is closely related to the ability to exploit the available resources of the environment (e.g. food resources) to produce living matter. We investigated fields of maize and sorghum that were grown for energy production, for ground beetles in three federal states of Germany in 2009 (from the end of May to the end of September in Brandenburg, from the beginning of July to the end of September in Mecklenburg-Vorpommern, and from the end of June to the end of September in Thuringia). We asked whether there are differences in the overall biomass as well as in the biomass on species level i) between the sexes of the beetles, ii) between the two crops, and iii) between the federal states. The carabids were collected with five ground traps at each plot. Individual biomass of the species was determined after drying the animals at 60° C for 24 h. The data were analyzed for differences with t-Test and One-way ANOVA, respectively, in total and individually for the most abundant species (*Calathus fuscipes*, *Harpalus affinis, Harpalus rufipes*, *Poecilus cupreus*, *P. versicolor*, and *Pterostichus melanarius*). Altogether, 17,082 individuals were weighed. The results revealed that, on species level the biomass was highest at the plots in Thuringia followed by that in Brandenburg and in Mecklenburg-Vorpommern, respectively (ANOVA, $p<0.01$). Moreover, the biomass was significantly higher at the stands of maize than at those of sorghum (t-Test, $p<0.05$). No significant differences could be found between males and females. In Thuringia, the biomass of the carabids remained nearly constant throughout the whole investigation period where as it dropped to half the value at the end of the trapping period at Brandenburg and Mecklenburg-Vorpommern. The results are discussed against the background of differences in the cropping time, differences between local climates and food availability at the plots.

O7 – Platform for sustainable aviation fuels-combining ecological research and sustainability management with industrial needs

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The International Air Transport Association (IATA) has set itself the target of carbon neutral growth from 2020 onwards and a 50% reduction in net CO_2 emissions over 2005 levels by 2050. Accepting this assumption and considering an IATA forecasted average fuel demand growth of 3% p.a. approximately 18 million tonnes of biofuel would be required in 2020 alone, an amount, which is similar in size to the global production of rapeseed oil in 2010. To meet this demand readily deployable and economically viable concepts for the sustainable production of bio-kerosene feedstock are urgently required. As part of the Innovation Incubator at the Leuphana University, Lüneburg, the "Platform for Sustainable Aviation Fuels" investigates two concepts for the sustainable production of plant oil: i) the cultivation of two members of the Brassica family, *Thlaspi arvense* (L.) and *Camelina sativa* (Crantz) in double cropping systems in Germany, and ii) the production of oil from the neotropical hemerophilous palm *Acrocomia aculeata* (Jacq.) in managed silvopastoral systems in Brazil. In our paper we briefly outline these concepts and discuss their suitability as ecologically and socio-economically sustainable biofuel feedstock production pathways. We present initial results from experimental studies on the ecological sustainability of plant oil production in German double cropping systems and also address inter- and transdisciplinarity challenges, such as the definition, measurement and/or certification of sustainability. As many current funding opportunities, particularly those associated with bioenergy, require some form of industrial application or cooperation with a commercial partner, we summarize our experiences with industry-orientated research within the Innovation Incubator.

O8 – Paludiculture - an alternative way to produce renewable resources and to release pressure on crop farmland

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Peatlands cover only 3 % of the global land surface, but contain one third of the global soil carbon. About 10% of the world's peatlands are drained for various purposes, mainly agriculture and forestry, and emit 2 Gton CO2 per year. Drainage of peatlands causes severe environmental problems including soil degradation, greenhouse gas emissions, nutrient efflux and loss of biodiversity. Furthermore, the continuous lowering of the peat surface requires continuous investments in deeper drainage. Paludiculture (Latin 'palus' = swamp) provides new land use opportunities that avoid peat degradation by installing and maintaining permanently water saturated soil conditions. The concept of paludiculture has primarily been developed as a land use alternative for cut-over peat bogs, e.g. for the cultivation of peat moss (Sphagnum farming) and for intensively drained and degraded agricultural peatlands. However, biomass from protected area management can also be utilized in the processing lines developed for regular paludicultures. Depending on land use intensity, paludiculture can provide a strategy to integrate nature conservation management in mainstream agricultural land use.

The peatlands of the German federal state of Mecklenburg-Vorpommern cover approximately 13 % of the state area and have been almost completely drained and used for agriculture. They are estimated to emit 6 Mio t CO2eq a-1 equating to 27% of the state's overall greenhouse gas emissions. Alternative land use options must be developed and implemented to reduce GHG emissions. The VIP Project (Vorpommern Initiative Paludiculture) develops and implements new forms of paludiculture on degraded peatlands in Northeast Germany. New techniques for harvesting biomass from wet peatlands and for using wetland biomass as a raw material for industry and for energy generation are tested, the impact of paludiculture on selected ecosystem properties and functions is investigated and the acceptance of this new landuse type in the region is analyzed.

O9 – Vascular plant species diversity of Short Rotation Coppice plantations (SRC) in agricultural areas

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As promising renewable energy source and additional landscape element, the potential role of short rotation coppice (SRC) plantations to biodiversity is of great interest. In Central Sweden and Northern Germany, the phytodiversity of willow (*Salix ssp.*) and poplar (*Populus ssp.*) SRC plantations was compared with surrounding arable lands, grasslands and forests. Plant species richness in eight landscapes (225 km²) containing SRC plantations and the related SRC α-diversity to species richness in the landscapes (γ-diversity) was studied.
Species number per area was higher in SRC plantations than in arable lands, coniferous forests and mixed forests in Germany. It was similar to that of grasslands and slightly lower than in marginal grassland strips and Swedish mixed forests. Species composition was determined by the degree of canopy cover: at increased tree cover, SRC plantations became less similar to grasslands but more similar to forests. The habitat-specific species diversity was highest in SRC plantations.
In accordance with the mosaic concept, the number of habitat types proved to be a significant predictor for species richness: the more habitat types, the higher the γ-diversity and the lower the proportion of SRC plantation α-diversity to γ-diversity. SRC plantations contained a subset of the landscape species pool that comprised on average a share of 6.9 % and were more dominated by species adapted to frequent disturbances and anthropo-zoogenic impacts than surrounding landscapes.
Our results show that SRC plantations can contribute positively to phytodiversity in agricultural landscapes, especially in areas dominated by arable fields and coniferous forests, as well as in landscapes with low habitat heterogeneity. Plant diversity enrichment was mainly effected by additional common perennial species typical for disturbed and anthropogenic environments. Species composition changes over time. Therefore we conclude that several different SRC plantations with varying crop species, ages, and cutting cycles are more beneficial for phytodiversity than large monocultures.

O10 – Assessing the ecological effects of the cultivation of *Miscanthus* x *giganteus* in marginal landscapes

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Marginal landscapes often feature a high biodiversity, which is threatened by either intensification or land abandonment. The increasing demand for land needed for bioenergy production is one main driver of land-use change. However, the production of low-input perennial crops might even provide ecological benefits at the landscape scale and economic opportunities for the declining number of farmers in marginal regions.
To determine the effects of bioenergy production at a relevant scale, we analyzed the potential economic and ecological consequences of *Miscanthus* production for one municipality located in the Taunus mountains (Hesse, Germany).
We used nationwide available field-scale data on soils (German Soil Inventory), land use (IACS data), a terrain model and the ProLand economic model to predict a potential yield for all agricultural fields. Each field was then classified according to the potential ecological effects of *Miscanthus* production, considering biodiversity, soil erosion and landscape structure. Further, we differentiated and evaluated the ecological landscape-scale effects by an analysis of the "landscape plan", which is mandatory and available for each German municipality and which provides specific information on conservation and land-use related potentials and shortcomings.
The resulting maps indicate preferential and exclusion zones for *Miscanthus* cropping. The potential yield at the landscape scale was calculated for various proportions of *Miscanthus* in the landscape. The methods applied in our exemplary study combine economic and ecological approaches, are based on existing data and methods, and allow an effective evaluation of the sustainable landscape potential of an energy crop at a scale relevant for biodiversity conservation and landscape planning.

O11 – Bioenergy crops: implications for farmland biodiversity in Ireland

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Adopting the Kyoto Protocol has stimulated the search for methods to reduce net CO_2 emissions. The urgency for mitigation actions has encouraged the rapid expansion of the bioenergy sector, potentially resulting in major land-use changes. Here we report on a study that assessed the impact of replacing traditional agricultural crops with *Miscanthus x giganteus* on plant, pollinator and carabid beetle diversity and abundance and the composition of their communities. Fifty sites were selected across south-east Ireland, ten replicates of five treatments (crop types): (1) *Miscanthus* on former tillage, (2) *Miscanthus* on former grassland, (3) oilseed rape, (4) a tillage control and (5) a grassland control. Plants, pollinators and carabid beetles were surveyed at the margin (next to hedgerow), edge (next to crop, ~3m from hedgerow), and centre of fields on two occasions during summer 2009. Different responses to the treatments were shown for the plants when compared with pollinators and carabids in terms of species richness and abundance. Communities within *Miscanthus* were most similar to other perennial crops, and most dissimilar to the annual crops: replacing traditional crops with *Miscanthus* did not result in novel communities except for the plants. Landscape metrics were used to reveal the effects of surrounding landscape structure on these results. Overall, growing *Miscanthus* did not result in an obvious negative impact on biodiversity measured at the field scale. However, achieving targets of reducing biodiversity losses by 2020 and maintaining ecosystem services will require a greater understanding of aggregated impacts at the landscape-scale to ensure the sustainable development of climate change mitigation measures in Ireland.

O12 – Biodiversity in *Miscanthus* x *giganteus* during the crop establishment phase

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Miscanthus x giganteus is one of the most important energy crops grown in the southeast of Ireland. A mature stand of *Miscanthus* is characterized by very dense vegetation which can grow up to a height of three meters. In practice, however, the development of a stand of *Miscanthus* is often patchy with gaps in the crop vegetation. Such gaps exist in particular during the first three years of establishment of the crop. A couple of studies have reported positive effects of Miscanthus on biodiversity [e.g. 1]. The aim of our study was to test whether those positive effects depend on the patchiness of a stand and whether there are trade-offs between the yield and the promotion of biodiversity.

We studied 14 *Miscanthus* stands at the end of their establishment phase (3-4 years after planting). Seven stands were established on arable land (MT), seven on grassland (MG). Patchiness of the stands was mapped with a GIS-Mapper along two 100m-transects. Ten sampling points were allocated randomly along the transects. At each sampling point the vegetation was surveyed in 1m x 1m quadrates, epigaeic arthropods were sampled with pitfall traps and relative light intensity (within and above the stand) was measured with a Lux-meter. Yield was estimated by counting the number of *Miscanthus* stems along perpendicular transects (4m x 20cm).

Light intensity had a high importance for the number of plant species and vegetation cover of non-crop plants in the stands. Vegetation cover was higher in MG than in MT stands. An increase in vegetation cover had a positive impact on species richness of ground beetles and on activity density of spiders. The impact on latter was higher in MG than in MT. Patchiness of a *Miscanthus* stand is responsible for an increased species richness and activity density of some species groups. With an increase in yield, activity density of epigaeic arthropods is decreasing. As patchiness is decreasing with the maturation of a stand

(5-20 years), a mosaic of establishing and mature stands at the farm or landscape scale would be necessary to support biodiversity in the long term.

[1] Emmerson M et al. (2011) The food versus fuel debate – what effect will replacing traditional crops with *Miscanthus x giganteus* have on farmland biodiversity? In: Ó hUallacháin D and Finn J (eds) Conserving farmland biodiversity, Lessons learned & future prospects. Teagasc Biodiversity Conference, Wexford, 58-59.

P1 – Effects of long-term cutting of rewetted fens on species diversity

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Extensive peatland drainage in Central Europe and worldwide has resulted in high rates of peat decomposition, greenhouse gas emissions, surface and groundwater eutrophication, and habitat loss for endangered species. Nowadays farmers often abandon the cultivation of drained peatland because of raising costs and decreasing economic benefits. From an environmental, social, and economic point of view rewetting these areas is important to reverse the abovementioned negative impacts of drainage. Developing and implementing new forms of biomass use on rewetted peatlands as a renewable resource for e.g. bio fuels or insulation material would provide alternative income sources for farmers. At the same time this so called Paludiculture can help to preserve the remaining peat body with its environmental functions and therefore displays an alternative way of site adapted utilization.

In Western Pomerania many formerly drained fens have been rewetted without any management measures, i.e. allowing free succession. These sites are characterized by a mosaic of a few dominant rhizomatous helophytes (e.g. *Phragmites, Typha, Phalaris, Glyceria*). However, a few examples of long-term cutting with different mowing regimes exist (winter & summer mowing). In our study we investigated the effect of long-term cutting on the vegetation and species diversity in rewetted fens to evaluate how annual cutting relates to nature conservation aims for fens.

Preliminary results show that rewetted fens without cutting show a higher species density and harbor more endangered species compared to managed sites. Our results are in contrast to the common expectation that regular mowing on meadows leads to an increase of plant diversity.

P2 – Agroecological assessment of the cup plant (*Silphium perfoliatum* L.) as a biomass crop of the future

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To counteract short maize crop rotations and monotonous agricultural landscapes, the cup plant *Silphium perfoliatum* with its high yielding ability is a promising candidate for biomass production. The perennial lifecycle, long-lasting flowering period and low tillage imply positive effects on biodiversity and ecosystem services. Experience from agricultural practice also indicates a comparatively high drought tolerance of *S. perfoliatum*.

We investigate the impact of *S. perfoliatum* on agroecosystems with a focus on functional aspects of biodiversity and water use. The aim is to provide scientific guidance for a sustainable establishment of the cup plant cropping system. The project is divided into two work packages:

WP1 Biodiversity and ecosystem functions above- and below-ground

Above-ground we perform

- Qualitative and quantitative assessment of the flower-visiting insect community in a landscape context
- Analysis of plant-pollinator networks of the cup plant and surrounding crops
- Examination of quality and quantity of the cup plant's floral resources (nectar and pollen)
- Assessment of the seasonal habitat quality for pest and beneficial organisms as well as arable weeds

Below-ground we perform

- Assessment of soil fauna communities: Nematode (micro-), collembolan (meso-) and earthworm (macrofauna) diversity in
  - crop stands of different age
  - during the vegetation period
- Evaluation of the functional role of soil biodiversity
- Analysis of decomposition dynamics of crop residues
- Assessment of earthworm soil surface castings
- Analysis of C- and N- dynamics in soil

WP2 Water balance and ecophysiology

- Analysis of water consumption in permanent culture
- Assessment of water use efficiency on single leaf and field plot level
- Characterisation of the root system depending on the soil moisture
- Testing the significance of the "cups" for the water balance
- Monitoring of soil water content over the course of the year
- Studying the temporal development of soil cover and leaf area index

The project is funded by FNR/BMELV
(http://www.vti.bund.de/de/startseite/institute/bd/projekte/silphie.html)

Session 2 – Biogeochemical cycles in a changing environment

Chairs: Ansgar Kahmen, Alexander Knohl

O1 – Plant soil-atmosphere coupling – lessons from beech and spruce

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The respiratory use of recent photoassimilates versus reserves in forest trees displays enormous spatio-temporal dynamics and responsiveness to environmental influences. This paper focuses on the allocation of recently fixed carbon (C) from the canopy to stems, roots and soils, comparing deciduous and evergreen tree species, i.e. *Fagus sylvatica* and *Picea abies*, respectively. Stable carbon isotope labeling of complete canopies of adult forest trees was employed by a free-air exposure system ("tubeFACE", Grams et al. 2011). Quantification of fluxes of recent photoassimilates to woody tissues and, in particular, to soil respiration were studied in response to seasonality, competition and seven-year long O_3 exposure (Andersen et al. 2010, Kuptz et al. 2011, Ritter et al. 2011). The observed patterns in C fluxes in the plant-soil-atmosphere continuum were dominated by the tree's phenology and gave insights in mechanisms of tree growth and respiration under a variety of environmental scenarios and seasonal dynamics.

- Andersen C P, Ritter W, Gregg J, Matyssek R, Grams T E E (2010) Below-ground carbon allocation in mature beech and spruce trees following long-term, experimentally enhanced O_3 exposure in Southern Germany. Environmental Pollution 158: 2604-2609
- Grams T E E, Werner H, Kuptz D, Ritter W, Fleischmann F, Andersen C, Matyssek M (2011) A free-air system for long-term stable carbon isotope labeling of adult forest trees. Trees-Structure and Function 25: 187-198
- Kuptz D, Fleischmann F, Matyssek R, Grams T E E (2011) Seasonal patterns of carbon allocation to respiratory pools in 60–year-old deciduous (*Fagus sylvatica*) and evergreen (*Picea abies*) trees assessed via whole-tree stable carbon isotope labeling. New Phytologist 191: 160-172
- Ritter W, Andersen C P, Matyssek R, Grams T E E (2011) Carbon flux to woody tissues in a beech/spruce forest during summer and in response to chronic O_3 exposure. Biogeosciences 8: 3127-3138

O2 – Greenhouse gas fluxes in mountain grassland differing in land use

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Mountain grasslands cover large areas and have been strongly affected by changes in land management and land use. Effects of such changes on the greenhouse gas (GHG) balance have so far not been well documented. As a contribution to the EU-project GHG Europe we are studying the net ecosystem exchange (NEE) of carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) on a mountain meadow, an adjacent pasture and an abandoned grassland at 1820-1970 m a.s.l. in the Austrian Central Alps. The GHG balance is derived from manual and auto-chamber measurements based on one (CH_4, N_2O) to ten (CO_2) years of data. Winter CO_2-fluxes, primarily due to soil respiration underneath the snowpack, are estimated with solid state CO_2-sensors using a validated diffusion model. We found that abandonment decreases the NEE of CO_2 and its component fluxes gross primary productivity (GPP) and ecosystem respiration (Reco), while, interestingly, it can enhance soil respiration (Rs). The decrease in GPP and Reco is explained by differences in leaf area index, biomass and changes of leaf physiology. The increase in Rs may be caused by higher litter input on the abandoned site. The meadow and pasture had low emission rates of N_2O even after freeze-thaw cycles and organic fertilization, while the abandoned grassland was characterized by a small N_2O uptake. CH_4 fluxes were dominated by uptake (CH_4 oxidation) at all sites, which increased from the meadow to the pasture and the abandoned site. These results suggest that decreasing land use intensity leads to a reduction of all GHG fluxes in mountain grassland and that CO_2 fluxes are the major determinant of the GHG balance.

O3 – Spring drought reduces evapotranspiration and aboveground biomass production of irrigated mountain grassland

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A reduction of spring rainfalls is the only distinct effect of climate change on precipitation patterns observed in context with climate change during the last decades in the North Italian region of Trentino-South Tirol. A project by the European Academy Bolzano and the University of Innsbruck is therefore investigating the effects of early season droughts on irrigated mountain grassland at 1500 m a.s.l. in the inner-alpine dry area of the Matsch Valley/Vinschgau. We are expecting a decrease of transpiration, soil water content, seepage and plant growth with increasing water shortage. To measure water balance continuously nine automatic lysimeters with a diameter and depth of 0.3 m were installed in 2011; in addition to lysimeter weight, soil moisture and water potential in 2 depths and the volume of seepage is recorded every ten minutes for each lysimeter. Aboveground biomass is measured after cutting the vegetation in accordance to local management. Starting right after snowmelt in March 2012 three lysimeters were sheltered from any rainfall and irrigation with a foil tunnel, three others were left

unsheltered and exposed to rainfall and irrigation, and the last three were sheltered but irrigated to outside conditions to quantify the tunnel's impact on microclimate. Early results show a clear reduction of biomass and evapotranspiration in dry, sheltered lysimeters especially after increasing temperatures and rainfalls/irrigation trigger plant growth in the outside ones in late April.

O4 – Does nitrogen deposition increase drought susceptibility of plants? Experimental evidence from heathland species

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Global environmental change is a major threat to biodiversity. Climate change and atmospheric nitrogen (N) loads are among the most relevant key drivers of biodiversity loss, but little is known about their interactive effects on biodiversity patterns and ecosystem functioning. Heathlands, which host a huge proportion of the biodiversity typical of semi-natural landscapes in NW Europe, are considered particularly susceptible to airborne N loads and shifts in climate (such as increasing summer drought).
We investigated response patterns of two important heathland species (the dwarf shrub *Calluna vulgaris* (L.) Hull and the perennial grass *Molinia caerulea* (L.) Moench) to combined effects of N fertilisation and drought events. We conducted full factorial 2-year greenhouse experiments to test the hypothesis that increasing N availability will increase the plants' susceptibility to drought (in terms of productivity, formation of necrotic tissue and N allocation using ^{15}N tracer). We also tested whether *Calluna* plants from different provenances (i.e. two central populations vs. two rear edge populations) differ with regard to treatment responses (in terms of biomass productivity, tissue nutrient concentration, tissue ^{13}C signatures).
We found interactive effects of N fertilisation and drought, expressed by a strong increase of necrotic tissue and less pronounced fertilisation effects in the drought treatment. Moreover, treatment responses (in terms of shifts in productivity and tissue nutrient concentrations) were strongly provenance-specific.
We hypothesise that increased water requirements due to increasing aboveground productivity (resulting from N fertilisation) led tohigherdrought susceptibility. Provenance-specific responses suggest that rear edge population show a higher adaptability to climatic shifts (i.e. increasing summer drought) compared to central populations.

O5 – The effect of air humidity on decomposition in the dry season

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Decomposition of plant litter is a key process in biogeochemical cycles of major elements. In light of the strong link between global warming and the carbon cycle much effort was dedicated in recent years to improve the understanding of plant litter decomposition and to quantify the products of this process such as CO_2. These efforts led to the discovery of new mechanisms for decomposition, such as photodegradation, in addition the absorbance of air humidity by litter was shown to facilitate decomposition in dry ecosystems. But the mechanisms involved in this process are unknown.

The goal of my work is to characterize litter decomposition resulting from water vapor absorbed during the rainless season and describe the mechanisms involved. We predicted that the high air humidity in this climate zone will allow microbial decomposition of plant litter in the dry season. A litter bag experiment was conducted on the Carmel ridge in Israel which has a Mediterranean climate and is close to the sea. Litter bags containing standard litter (wheat straw) and local litter were placed under evergreen and deciduous shrubs and in open areas to allow different microhabitat conditions. In the field during predawn and midday we measured CO_2 fluxes from the litter bags using a respiration chamber connected to an infrared gas analyzer.

Rates of decomposition of local litter were highly dependent on litter quality. For example, the litter of evergreen shrubs barely decomposed due to high lignin content. The standard litter showed small differences in mass loss between the habitats. This may indicate that when radiation is blocked another decomposition mechanism allows decomposition. During summer measurements the microbial biomass was approximately half of the microbial biomass which was present in the wet season during a rain event. Additionally the CO_2 fluxes observed at predawn along the dry season reached 1/6 of the fluxes measured in the wet season during a rain event and were strongly correlated with litter moisture content in all litter types. Taking into account the rate of mass loss (which reached up to 14% after 3 months), the presence of microbial biomass and the measured fluxes, microbial activity facilitated by air humidity appears to be an important driver for decomposition in the dry season.

O6 – Winter warming pulses affect nitrogen cycling in temperate heath and grassland communities

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Ongoing global warming is predicted to increase variability of winter air temperatures and to decrease snow cover over large areas of the temperate zone. This leads to more variable winter soil temperatures which potentially influence many biogeochemical processes.

In a controlled field experiment we investigated the effects of winter warming pulses on plant available nitrogen (N), plant N uptake, decomposition and N mineralization at two different sites (lowland site: Ecological-Botanical Garden Bayreuth and upland site with a more severe winter climate: Waldstein, Fichtelgebirge). Lysimeters with six different plant communities (4 monocultures of: *Holcus lanatus*, *Plantago lanceolata*, *Calluna vulgaris*, *Deschampsia flexuosa*; and two-species mixtures: *H. lanatus* and *P. lanceolata*, *C. vulgaris* and *D. flexuosa*) and one bare ground control were installed. Winter warming pulses were applied by IR-heaters and aboveground heating wires. This treatment was compared to ambient conditions in five replicates per site.

We tested for differences in (1) plant available N (resin sticks), (2) N uptake by plants (^{15}N), (3) mineralization rates (net mineralization bags) and (4) decomposition (litter bags and bait-lamina sticks). Winter warming pulses increased plant available N by 34.5%. N uptake was per unit biomass was increased ($D^{15}N$) while ANPP decreased. This led to no change in total N uptake.

Decreased plant biomass despite increased N availability in response to winter warming pulses (higher mineralization rates and decomposition) indicates that plant uptake was limited by other factors, presumably frost damage. Consequently increased N leaching has to be expected against which plant activity cannot buffer. The results indicate the high ecological importance of winter climate change in the temperate zone.

O7 – Contrasting winter climate change effects on biogeochemical cycles in boreal and temperate systems and between magnitudes of change

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Climate is changing, with observed warming being greatest at higher northern latitudes and in winter. However, climate warming is expected to lead to contrasting effects on winter soil conditions, as reduced snow cover will lead to stronger soil frost in the still-cold boreal ecosystems, while in temperate ecosystems the warming will eventually cause the complete loss of soil frost.
Based on three field experiments, I show that the response of soil biotic activity to winter climate change differ between boreal and temperate sites. (1) A long-term snow removal experiment in a boreal forest (northern Sweden) implied that annual decomposition rates can be reduced by 50% due to increased soil frost in consequence of reduced snow cover. (2) A continuous winter warming in a temperate grassland (southern Germany) did not affect annual litter decomposition rates, probably due to decreased snow cover which led to almost no effect in soil temperature during winter. (3) A stronger soil warming that avoided any soil frost at the same site, however, increased soil respiration during the warming phase by 291%. N-availability was not significantly affected, probably because plants increased nitrogen uptake during winter 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.
I conclude that the effects of winter climate change on biogeochemical cycles will depend on snow cover. A reduction of snow cover leading to more variable soil temperatures is expected to counteract increased carbon loss and positive feedback on global warming in boreal ecosystems. The same effect may occur transiently in the temperate zone, yet only until the cooling capacity of missing snow cover is exceeded. Yet, plant response appears crucial with regard to nutrient leaching and carbon sequestration, as enhanced primary productivity may keep nutrient cycles closed and provide additional organic matter to compensate for increased decomposition.

O8 – The role of Calcium and Magnesium in Iron cycling

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Occurring in wells, pipework, natural groundwaters, and in soils, the oxidation of ferrous iron is a partly abiotic-, partly biotic-induced process. Bacteria play a major role in the iron cycle, as they reduce and oxidate iron and closely connected elements like sulfur, affecting bioavailability of nutrients in most environments.

Whilst chemolithoautotrophic iron oxidizing bacteria, such as *Gallionella* spp. rely solely on ferrous iron oxidation as energy source, other heterotrophic organisms, *Lepthothrix* spp. for example, can apply their ability to catalyze ferrous iron oxidation. Furthermore, their ability to oxidize iron is nearly all of what is known about these bacteria, save for some findings made by studies concerning their requirements (carbon metabolism [1, 2], Mn oxidation [3], O_2, pH [4]). But knowledge regarding other their nutritional or habitat needs or other requirements is still scant.

The study established that Ca and Mg concentrations influence *Gallionella* sp. and *Lepthothrix discophora* growth, as concentrations of these two cations vary over a wide range in natural groundwaters and are routinely analyzed. Ca and Mg concentrations in culture media were made to undergo variations over a range covering typical natural groundwaters values (Ca: 0.6-150 mgL^{-1}, Mg: 0.12-24 mgL^{-1}). Using optical density and TOC measurements as well as light microscopy, growth rates and maximum cell densities of the model organisms were determined in batch culture. Lowering the two cations corresponding to values in soft natural groundwater reduced both the growth rates and maximum cell densities. Growth occurred even at low nutrient concentrations.

The two organisms used in this study grow more slowly under natural conditions than in artificial culture medium, even at sufficient Ca and Mg concentrations.

Other factors evidently inhibit the growth of the two model organisms more than Ca and Mg do. In very soft groundwaters though, Ca and Mg concentrations, among other factors, may lead to reduced growth rates of *Gallionella* sp. and *Leptothrix discophora*.

- [1] Kämpfer et al. (1995) *Water Res* **29**, pp 1585–1588
- [2] Hallbeck, Pedersen (1991) *J Gen Microbiol* **137**, pp 2657–2661
- [3] El Gheriany et al. (2009) *Appl Environ Microb* **75**, pp 1229-1235
- [4] Eggerichs et al. (2011) *20th Int. Symp. on Environ. Biogeochemistry. Conf. Proc.* p. O72

O9 – Litter decomposition and global change effects on decay affected by silicon

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The decomposition rate of dead plant material is a main part of the global carbon cycle and may be affected by global change. Elemental composition and carbon compounds of the plant material control the decomposition rate of plant litter. For grasses, silicon is known as beneficial element to protect against fungi and invertebrate feeding. It may also change the nutrient stoichiometry as well as the content of structural carbon compounds in living plants where nothing is known about the role of silicon during decay. Furthermore, the mechanisms involved in the impact of global change on litter decay are still not fully understood. We show that the effect of simulated global warming as well as the effect of higher water nutrient concentrations resulting in enhanced decomposition rate could only be proven for leaf litter from plants grown under conditions of high silicon availability. For leaf litter from plants grown under lower silicon availability the simulated global change had no effects on litter decomposition rate. Furthermore, leaf litter of *Phragmites australis* grown under high silicon availability had a significant higher decomposition rate compared to litter grown under low silicon availability. Amorphous silica and silica bodies are partly dissolved during four months of litter decay. In addition, the carbon, nitrogen and silicon content of leaf litter after decay is significantly affected by silicon content at the beginning, by warming, nutrient addition and by a combination of warming with nutrient addition.

P1 – Short-term variability of atmospheric stable water vapor isotopes in the tropics (Sulawesi, Indonesia)

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High-frequency measurements of atmospheric stable water vapor isotopes provide insight into atmospheric transport processes and sources of water vapor. Here, we present continuous measurements of δ^2H and δ^{18}O of atmospheric water vapor made with a Picarro isotope analyzer (L2120-i, Picarro Inc.) in Palu, Central Sulawesi, Indonesia. The main objective was to determine the causes of short-term (days) and diurnal variations in atmospheric isotope ratios. Variations in values of δ^2H and δ^{18}O measured in precipitation were also explored. We first characterized the accuracy and performance of the Picarro in terms of precision and water vapour concentration dependency and then use isotope ratios of the precipitation in theoretical equilibrium with the water vapour to correct atmospheric measurements.

Half-hourly H_2O concentrations ranged from 18000 to 32000 ppmv, and average, minimum and maximum half-hourly values of δ^{18}O and δ^2H were -18.0, -29.0 and -10.7‰, and -131.0, -214.0 and -74.1‰, respectively. Large changes in atmospheric isotope values occurred over a week-long period in early May 2011, corresponding with shifts in air-mass trajectories. The peak-to-peak variation in diurnal ensemble average values of δ^{18}O and δ^2H was 1.5 and 11.2‰, respectively, while *d* varied by 3.3‰. Both air temperature and relative humidity were positively correlated with diurnal values of δ^{18}O and δ^2H (r^2 = 0.52, p < 0.005, for all relationships). Wind direction had a significant influence on diurnal *d* (r^2 = 0.82, p < 0.001), due to the prevalence of a land-sea/sea-land breeze at this site. Thus, day-to-day variation was driven by regional climate, diurnal variation by local climate.

P2 – Changes in litter quality and decomposition processes in the city of Hamburg, Northern Germany

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Speed of leaf litter decomposition is influenced by environmental parameters (temperature, humidity, etc.) as well as chemical composition of the leaves (content of lignin, N, C, etc.). All of the mentioned parameters can be altered by an urban environment, thus leading to changes in decomposition speed. Since urban areas spread throughout the world and decomposition processes are a crucial step in the global carbon cycle, understanding and quantifying these changes is of global interest. Questions of interest are i) How is litter decomposition altered in an urban environment? and ii) What leaf litter quality parameters are responsible for these changes?
Methods employed in the study include *in situ* litter bag experiments in and around the city of Hamburg, allowing exposure and later retrieval of leaf litter to natural decomposition regimes, as well as *in vitro* incubation experiments of leaf litter of both urban and rural origin. Additionally, leaf litter will be analyzed to determine responsible changes in leaf litter composition.

P3 – Responses of major plant functional types to an increase in atmospheric CO_2 concentration: A modeling approach of drylands

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An increase in the atmospheric CO_2 level can involve various responses of plants. Species can for example alter their biomass production, net carbon assimilation, water use efficiency or root to shoot ratio. Since species' responses can be highly diverse, future vegetation composition of dryland ecosystems will strongly depend on the interplay between these responses. However, when assessing future vegetation composition of an ecosystem it is not feasible to resolve changes at species level. Instead the grouping of different species into response groups is required.
In this study, we review the response of major plant functional types (PFTs) such as C3 and C4 grasses, trees, shrubs and legumes towards increased CO_2. These PFTs differ in metabolism, growth patterns, dispersal and environmental demands and therefore have high potential to respond differently to elevated CO_2 concentrations. We evaluate the response of different processes at different stages of their life cycle and categorize PFTs or sub-PFTs into different response types.
Based on this, we introduce a concept of how to integrate these findings into an existing model of the coupled dynamics of water and vegetation in a dryland system. This model can then be used to assess the shifts in vegetation patterns as a result of interacting non-linear effects of altered environmental conditions including changes in precipitation, temperature and CO_2.

P4 – Climate versus vegetation controls on the water balance of mountain grasslands across the Alps

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As mountain regions are a major source of water for a large part of mankind, understanding drivers and controls of water balance in mountain ecosystems and possible effects of climate and land use should be a primary concern of mountain research. While climatic controls of water balance are well understood, the impact of vegetation besides a general increase of evapotranspiration with leaf area/biomass is rather unclear. We hypothesized that in alpine grasslands, plant structural and functional composition is a key determinant of water balance by influencing processes like evapotranspiration, interception and water uptake from the soil. The project presented used a total of 220 deep seepage collectors (DSCs, diameter 25 cm, depth 30 cm) with different plant functional composition at three different sites across the Alps (Lautaret/France, Furka/Switzerland, Stubai/Austria) to determine deep seepage and soil moisture content. As precipitation was measured among other meteorological parameters and surface runoff was eliminated by the design and horizontal placement of the DSCs, evapotranspiration could be calculated as the residual in the water balance equation. In order to relate water balance to the plant canopy, species composition as well as cover, height, phytomass of functional groups were measured for each monolith. We found large variability of seepage and evapotranspiration within each study area and clearly higher evapotranspiration to precipitation ratios at the dry French site than at the more humid Austrian and Swiss site. While climatic drivers and biomass impact evapotranspiration at each site, an influence of other structural and functional vegetation properties was far more significant at the humid sites.

P5 – Field monitoring of microclimate: new combined thermal and soil moisture standalone unit

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The exceptionality of microclimate is well known especially thanks to the famous Geiger's book on "The climate near the ground". Microclimate has been also recognized to be an important ecological factor driving pattern of species distribution on different scales. The importance of microclimate as a potential buffer of recent climate change, especially of rising global temperatures, is also recently emphasized by many ecologists. Despite these facts, there is still large lack of studies related population or community ecology (no matter which sub-field), to the detailed microclimatic condition. One of the reasons could be unavailability of appropriate microclimate-measuring tools. To fulfill this gap we developed new

standalone unit for continuous monitoring of microclimatic condition at small scale that plant can experience.

The unit (TMS2) manufactured by TOMST s.r.o. imitates the body of small plant with about 10 cm long root and 15 cm long stem. The unit incorporate: i) three calibrated thermometers with accuracy ±0.5 °C measuring approximately at -10, 0 and +15 cm relative to soil surface, ii) soil moisture sensor based on time domain transmission principle and iii) full life time (app. 5 years operation) data storage (0.5 mil. logs) and batteries. The unit was designed based on large laboratory and especially field experience with first TMS1 model. We have successfully used the first version for e.g.: i) long-term monitoring of microclimate in rugged relief of sandstone landscape, ii) precise measurement of habitat conditions of several rare and nationally endangered species of vascular plants, bryophytes and fungi and iii) continuous measurement of temperature and moisture of coarse woody debris in mountain spruce forest. The original version, employing the same technology of measurements as the new unit, proved durability in harsh outdoor environment with good functioning in wet conditions across all field studies.

Session 3 – Biological Invasions

Chairs: Ingolf Kühn, Viktoria Wagner

O1 – Spatial vs kin selection: What drives invasions?

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It is well known that during range expansion the spatial assortment of highly dispersive individuals at the range margin leads to a further increase of a population's dispersiveness.

An aspect largely ignored in this respect is the influence of kin selection. It is, however, evident that frequent and successive founder effects at range margins will lead to the emergence of strong kin structure. We hypothesize that over several generations, this process may contribute even stronger to the evolution of highly dispersive individuals than the spatial selection process.

We investigate the effect of kin and multi-generation selection using individual-based simulations. We find that if we destroy the kin structure of marginal populations (cf. Poethke et al. 2007), dispersal increases much less during range expansion periods, leading to slower rates of spread. The relative contribution of kin selection to an increase of dispersal depends on landscape conditions and is especially prominent if the habitat (at the range margin) is very fragmented.

Our results thus demonstrate the strong influence of kin selection for the evolution of increased dispersal during range expansion.

- Poethke et al. (2007). Evolutionary Ecology Research, 9, 41-50.

O2 – The adaptive evolution of an invasive tree

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Before non-native species are considered as invasives, they have to pass several stages, and rapid adaptive evolution is suggested to positively enhance establishment of invasives. Altered phenotypic traits may thus contribute to an enhanced tolerance to biotic or abiotic conditions in invasive populations. Comparisons of native and invasive populations in a common environment are necessary to understand the genetic background that allows rapid adaptive evolution.

We focused our study on the evolutionary adaptation of germination and postgermination traits in invasive trees using *Ulmus pumila* L. (Ulmaceae) as a biological model. In a comparative germination and greenhouse experiment using invasive populations from Argentina as well as the U.S. and native

populations from China, we found that populations from both invasive ranges outperform native populations. Furthermore, this enhanced performance of invasive populations seems to be adapted to current climatic conditions and both invasive ranges are characterized by a significant higher genetic diversity compared to the native range.
Our work shows that rapid adaptive evolution of germination and postgermination traits of invasive populations towards current climatic conditions are one of the potential drivers for the invasion success of *U. pumila.* Moreover, we assume that the ability for rapid adaptation is supported by multiple introductions from different regions of the native range, resulting in increased genetic diversity levels of invasive populations due to intra-specific hybridization.

O3 – Human Release, the success story of an invasive shrub

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[4]Senckenberg Museum of Natural History, Görlitz, DE

Our study species, *Rosa rubiginosa* L., invades native plant communities forming large monotypic stands in its introduced range. We aimed to identify whether propagule pressure, the abiotic characteristics of the invaded ecosystem, and the biotic characteristics of the recipient community and the invading species are drivers of its invasion success (Catford et al 2009). A comparison of native populations in Europe with invasive populations in Argentina ruled out all factors except for the biotic characteristics of the invading species. Characteristics such as its high phenotypic plasticity, predominant asexual reproduction and its ability to tolerate a wide range of edaphic and climatic conditions contribute to its invasion success. However, this raises the question why these attributes do not result in a high abundance and population size in the native range as well. This can be explained by different land-use practice in the native and introduced range. In order to test for the Enemy Release Hypothesis we compared leave damage between native and invasive populations. Leave damage did not differ between ranges, but removed or pruned shrubs only occurred in the native range. This result highlights a reframing of the Enemy Release Hypothesis, where the human enemy must be considered together with other agents, and in our case study, the invasive species has successfully escaped its human enemy. This is the first population ecology study that has revealed land-use as a limiting factor for an invasive species in its native range. *Rosa rubiginosa* is restricted to only a few viable habitats inside its native range and it is increasingly endangered due to anthropogenic land-use changes.

- Catford JA, Jansson R, Nilsson C (2009) Reducing redundancy in invasion ecology by integrating hypotheses into a single theoretical framework. Divers Distrib 15:22–40

O4 – *Senecio inaequidens* along an urban-to-rural gradient: responses to interactions with native species and elevated temperature

Katharina J. Schmidt[1], Nikola Lenzewski[1], Dennis Schulze[1], Jonathan Steinke[1], Kai Jensen[1]

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Future climate predictions state elevated temperature and CO_2-concentrations as well as poorer water availability during growing season. Many urban areas in Central Europe already feature these conditions and plant species originating from warmer regions are often able to establish there first. Our study analyses the impact of climate change on a thermophilic alien plant species regarding germination, herbivore defence, and competition.

In Hamburg, the study species *Senecio inaequidens* has been spreading rapidly since 1988 and preferably colonises brownfield, road side and railroad habitats. So far, *Senecio inaequidens* seems to colonise unoccupied ecological niches and does not displace other species. Considering its ongoing spread, the species is expected to invade agricultural land eventually. All plant parts contain toxic pyrrolizidine alkaloids (PA) for herbivore defence, contamination of produce could therefore lead to serious animal poisoning.

We assume that *Senecio inaequidens* has been spreading from the urban core to the surroundings of Hamburg. Furthermore, we expect the established populations to be able to adapt quickly to environmental conditions. Since the above-mentioned altered environmental conditions gradually increase towards urban centres, we conducted experiments with populations from different origins along an urban-to-rural gradient in Hamburg. Germination and responses to interactions with native animal and plant species – i.e. herbivory and competition - were studied under different temperature treatments. We tested whether the populations differ in their response to elevated temperatureto estimate their adaptation potential and their reaction to climate change.

O5 – Alien plant species in Europe: distribution patterns of absolute and relative richness

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We mapped alien plant species richness (neophytes - plants introduced since 1500 AD, archaeophytes - introduced earlier, and two groups combined) both in absolute and relative terms (total alien richness compared to native species, and neophytes compared to archaeophytes) at the European scale. We compared the richness patterns of native and alien species and tested whether relative richness of alien species is associated with human impact (human population density and agricultural land-use).

We combined data from two extensive plant atlases (Atlas Florae Europaeae and Atlas of north European vascular plants north of the Tropic of Cancer by Hultén and Fries) to obtain optimal species data coverage in Europe. We mapped species richness of archaeophytes, neophytes and natives species within 50 x 50 km grid squares. For relative alien species richness isometric logratio transformation was used in order obtain independent, orthogonal variables. We used General Linear Mixed Models with spatial autocorrelation setting for statistical tests.

Our results provide an extensive distribution map of alien plant species richness at the European scale. The total number of alien species increases from north to south in absolute numbers in Europe. The same trends hold true for absolute richness of archaeophytes and neophytes, although neophyte richness pattern is patchier. The numbers of alien species (total, archaeophytes and neophytes) are strongly positively related to the number of native species. The relative richness of alien species shows a much different pattern than the absolute numbers: aliens are more widespread in southern Europe and neophytes in northern Europe. Alien species are relatively more common in densely populated areas and in areas with more intensive agriculture. The relative abundance of neophytes (compared to archaeophytes) is also greater in densely populated areas but in non-agricultural land, demonstrating that ancient and recent invaders have distinct target ecosystems.

O6 – Effects of rodent herbivory on diversity and productivity of native versus invaded grassland communities

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Previous biodiversity experiments revealed a positive relationship between plant species richness and ecosystem functions such as primary production. However, these experiments often marginalized the role of multiple trophic levels, and considered the loss of native biodiversity but ignored the spread of exotic species. Other studies have shown that diversity and productivity of native plant communities can be profoundly influenced by herbivores. On the other hand, the dislocation of exotic species from coevolved relationships may lead to a disruption of species interactions, and the release from natural enemies can give them a competitive advantage over native species. These results suggest that ecological interactions and resulting ecosystem functions are shaped by a common co-evolutionary history among species. We therefore hypothesized that the relationship between biodiversity and ecosystem functions should differ between native communities and communities invaded by exotic plants. Since the role of generalist herbivores like rodents on the establishment of native vs. exotic plant species is not well understood, we particularly considered the impact of rodents on species recruitment and productivity of plant communities. Therefore, we set up a fully factorial seed addition x rodent exclusion experiment replicated at ten grassland sites in central Germany, covering a wide range of diversity and productivity. Adding mixtures of 20 native or 20 exotic species to grassland plots increased diversity by 4 to 6 species, irrespective of native vs. exotic seed origin and independent of rodent exclusion. Both, recruitment of additional species and rodent exclusion resulted in an increase in productivity, and highest productivity was reached in plots with rodent exclusion and exotic seed addition. The impact of exotic species on productivity and diversity was drastically decreased by rodent herbivory, indicating biotic resistance mediated by these generalist herbivores.

O7 – Impact of linear clearings on a highly diverse tropical mountain forest

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Linear clearings, such as roads or pathways, cause an important impact on natural ecosystems worldwide. So far knowledge of plant communities along linear disturbances and their invasiveness into tropical mountain forests is poor. This study shows the actual distribution of native and introduced species along linear clearings within a megadiverse tropical mountain forest of Southern Ecuador. We examined the ruderal flora along a highly frequented road within an altitudinal range between 900 m and 2,800 m a.s.l. and two often-used footpaths. We sampled the ruderal flora in transects parallel to the clearings and checked their occurrence along perpendicular transects from the clearing's edge into the natural forest. In total we found 582 native and 40 introduced plant species. 28% of the ruderal native species had a wide latitudinal distribution range, which exceed at least one tropic, whereas 7% of the species showed a local focus on our research area. Introduced plant species were stronger represented along the road than on pathways and preferred open landscapes than dense forests. Introduced species with a holarctic origin occur more frequently (68% of the introduced species) above 1,800 m a.s.l. and 67% of species within the lower half of the altitudinal gradient were of paleotropic origin. The linear disturbance leads on the road edge to a diversity decrease of 44% of the natural alpha diversity. However, ruderal flora showed low invasion ability into the tropical mountain forest.

O8 – Differential effect of wave stress on the physiology and behaviour of native versus non-native benthic invertebrates

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In fresh waters, non-native invertebrate species preferentially spread via navigation waterways, where they often dominate assemblages. Littoral habitats in navigation waterways are regularly exposed to ship-induced waves. We conducted experiments to test the effects of artificial wave exposure on the relative performance of wide-spread native and non-native species. We compared physiological and behavioural response variables (i.e. growth rate, glycogen content, feeding and swimming activity) of two amphipods (native *Gammarus roeselii* and non-native *Dikerogammarus villosus*) and two gastropods (native *Bithynia tentaculata* and nonnative *Physella acuta*) subject to wave and control (i.e. no wave) treatment flumes across a 6-week period. Growth, and in part glycogen content (as a measure of energy storage), were significantly reduced after exposure to waves in native invertebrates, but not in non-native invertebrates. The reduction in growth may be associated with the disturbance effects of waves, such as the higher swimming activity of *G. roeselii* and lower food uptake of *B. tentaculata*. In comparison, the effective hiding behaviour observed for *D. villosus* and good swimming ability of *P. acuta*, were identified as important traits facilitating the successful colonisation of the harsh habitat conditions of littoral waterways. Our study demonstrates that artificial wave regimes may contribute significant selective pressure, thus explaining the observed dominance of non-native species in navigational waterways. The success of non-native species under the harsh hydraulic habitat conditions

of these socio-economically driven ecosystems may consequently be traced directly to behavioural and/or physiological traits.

O9 – Impacts of invasion by *Picea sitchensis* on coastal heathland vegetation

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The North American conifer Sitka spruce (*Picea sitchensis* (Bong.) Carr.) is extensively planted in Britain, Ireland and along the Atlantic coast of northern Europe. Introduced conifers that spread from plantations and establish in native vegetation may pose a threat to local biodiversity. Sitka spruce is reported to be invasive in Britain and Ireland and it currently invades the key cultural landscapes of coastal heathlands in Norway. Yet, there is a lack of scientific knowledge of the ecological impacts of Sitka spruce invasions.
We assess how the spread of introduced Sitka spruce into *Calluna*-heathlands in western Norway affects vascular plants and bryophytes. Invasion effects are compared between introduced Sitka spruce and native Scots pine (*Pinus sylvestris* L.) along fine-scale transects from individual tree stems into open heathland vegetation. Scots pine is the only native conifer in western Norway. We measure soil and temperature conditions and the responses of the two species groups to tree canopies are assessed by calculating changes in mean Ellenberg indicator values. Principal response curves (PRC) and generalised linear mixed models (GLMMs) are used to investigate the effects on species composition and richness.
We found that distinct microcommunites developed beneath the canopies of single coniferous trees (2-4 m tall) and species composition differed beneath the introduced Sitka spruce and the native Scots pine; forest-floor species (especially bryophytes) had colonised to a greater extent beneath Sitka spruce, replacing the light-demanding species characteristic for coastal heathland vegetation. There was no difference in total species losses (on average 3-5 species near stems) beneath the two conifers, but vascular plant richness was reduced due to poor light conditions beneath the dense and low Sitka spruce canopies, whilst bryophyte richness was more negatively affected by warmer and drier microclimates beneath Scots pine. Increased sub-canopy nitrogen availability and pH may have contributed to vegetation changes beneath the two invading conifers.
In conclusion, our results indicate that Sitka spruce invasion may pose a more immediate threat to the characteristic coastal heathland vegetation than succession based on native conifers.

O10 – Parasite effects on the distribution of native and invasive amphipods on the Paderborn plateau (northwest Germany)

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Gammarids are well known as intermediate hosts of the endoparasite *Polymorphus minutus* which is transmitted to them by water birds as the so-called host predators. *Gammarus pulex* and *G. fossarum* are native species of the streams of the Paderborn plateau and *Echinogammarus berilloni* is an invader. Infection with *P. minutus* prevails in all three species. The distribution pattern of the gammarids is understood as a result of the complex interaction of invasion, parasitation, and predation pressure. We studied the geotactic and drifting behavior and the effect of the sympatrically occurring non-host predator (the three-spined stickleback – *Gasterosteus aculeatus*) on parasitized and unparasitized individuals of both native and invasive gammarids. We hypothesized that deviations from normal behavior due to infection are more distinct in native species compared to the invasive one. According to our results, parasitized *G. pulex* exhibited a more intense negative geotaxis than parasitized *E. berilloni* as well as unparasitized individuals of all three species. Avoidance of the non-host predator fish (probably by perception of kairomones) in unparasitized state was more distinct in the invasive species than in both native species. When gammarids were parasitized, however, the native *G. pulex* showed a significant avoidance of the non-host predator, compared to the invasive *E. berilloni* and the native *G. fossarum*. We discuss to what extent these results may explain the distribution patterns and invasion processes in relation to parasitism found in nature.

O11 – The effect of management methods on the invasive neophyte *Rosa rugosa* in coastal areas

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The invasive neophyte *Rosa rugosa*, which originates from East Asia, was introduced as an ornamental plant and, due to its resistance to weather and salt, planted in European coastal areas to stabilize dunes and coasts. Because of its effective reproduction, it spreads from these sites into neighbouring vulnerable dune areas, where it forms large, dominant and dense stands, which displace the native flora [1; 2].

The aim of this study was to investigate different grazing methods and their combination with cutting in their effectiveness to control *R. rugosa*. Therefore, in study sites in coastal areas in Germany and Denmark plots with and without management were compared. Furthermore, mappings of the roses from the German study sites from 2006/2008 were compared with recordings from 2011, when also cover and height of the roses were recorded.

Both investigation methods showed significantly reduced height and coverage of *R. rugosa* and, therefore, higher light availability in managed rose patches. In those, less fruits were found than in uncontrolled plots. Within treated plots litter was significantly reduced, whereas grasses and mosses had a higher cover than in untreated plots. The coverage of herbaceous plants was almost the same in

both, but species number was higher in managed plots compared to unmanaged plots. Species composition was significantly correlated with the coverage of *R. rugosa*.
We conclude that the applied management has a high efficiency in controlling *R. rugosa.* and allows rare and endangered plant species of these vulnerable coastal areas to recolonize the rose shrubs. However, during the observation period the area covered with roses increased despite of management measures, but coverage and height of the managed rose patches was lower than in unmanaged patches.

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- [2] Isermann, M. (2009). Expansion of *Rosa rugosa* in Coastal Dunes. *Bull. Eur. Dry Grassland Group, 2*, 14–15.

O12 – Insights from farmer interviews into the problems caused by invasive golden apple snails in irrigated rice in SE-Asia

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Pomacea canaliculata, commonly referred to as golden apple snail (GAS), was repeatedly introduced in South-east Asian countries with or without intent in the past 30 years. It has become an important pest feeding on young rice seedlings. Campaigns were launched by governments to warn and to inform farmers about the ecology and management of this novel threat. We conducted interviews on golden apple snails with rice farmers from 4 regions in Vietnam and 3 Regions in the Philippines varying in land-use intensity and cultural identity. We quantified their knowledge of GAS biology and management and asked for the source by which they obtained their knowledge. We explored if farmers received training on GAS management or not, and how their management has changed since then. GAS was present in all regions except for the mountain region in Northern Vietnam (Lao Cai province), where farmers did not know of a rice pest snail at all. Most other farmers announced that management of GAS is necessary to avoid losing much of their yield, and this is mostly done with the help of molluscicides, which, in contrast to insecticides, are applied regularly. Most farmers had constraints about the toxicity of the chemical pesticides but did not know of any effective, sustainable management methods. Farmers also noticed a decrease in the abundance of native edible snails and they assume that the thorough usage of molluscicides and competition with GAS might be the reasons for this. We suggest that the dissemination of information on GAS biology and on methods of non-chemical management to farmers should be improved and farmers be made aware of this spreading pest in areas which are not yet infested. Management of GAS should be centralized and synchronized in communes to make it more effective possibly combined with a profitable marketing.

P1 – Is the invasion success of non-native woody plants supported by reduced herbivores pressure?

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The invasion success of neophytes can be explained by various processes. One of the main hypotheses in invasion ecology is the Enemy Release Hypothesis, which assumes that host-specific enemies are absent in the new range, host switches by enemies of native congeners are not common, and generalist enemies have a greater effect on native competitors. However, novel enemies can affect introduced plants and counteract the invasion success. The prevention of a successful expansion of a non-native species due to natural enemies is consistent with the Biotic Resistance Hypothesis. In general, the attack of neophytes in their new distribution range by native herbivores is related to the plants' introduction time, their distribution area, and their phylogenetically distance to native plant congeners.
This study deals with plant-herbivore-interactions of non-native plants in their new range in comparison to those shown by congeneric native plants. We compared the leaf damage by insect herbivory of two pairs of plant species: *Prunus serotina* and *P*. *padus*, and *Rosa rugosa* and *R. canina*. These are suitable model systems because there are only few monophagous insect species occurring on *R. rugosa*, while there are many generalist insects on *R. canina* and *R. rugosa* in their native as well as non-native range. *R. rugosa* is invasive in coastal dune areas, but not further inland on the mainland. In contrast, *P. serotina* is invasive both in coastal and in inland areas. The study explicitly considers whether successful invasive species, like *P*. *serotina*, are less attacked by herbivores than non-native species that are, despite of habitats with similar local environmental conditions, not everywhere in the new range invasive, like *R*. rugosa on the mainland. However, biodiversity of insect species often is reduced on islands in comparison to mainland areas. Therefore, probably the invasion success of *R. rugosa* due to missing enemies is not reduced on the islands.
We aim to answer the following questions:

- Are native plant congeners attacked more by herbivores than neophytes?
- Does the degree of herbivory of the two pairs of woody species (*R. canina* and *R. rugosa*, *P. serotina* and *P. padus*) differ between coastal and inland areas?
- Are the differences in herbivory between regions and species consistent with the Enemy Release Hypothesis?

P2 – Invasion of *Impatiens glandulifera* affects terrestrial gastropods by altering microclimate

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Invasive species can have far-reaching impacts on ecosystems. Invasive plants may be able to change habitat structure and quality. We conducted a field experiment to examine whether the invasive plant *Impatiens glandulifera* affects native terrestrial gastropods. We also evaluated whether the invasive plant alters forest soil characteristics and microclimate which in turn may influence gastropod abundance. We sampled gastropods in plots installed in patches of *I. glandulifera*, in plots in which*I.*

glandulifera was regularly removed by hand, and in control plots which were not yet colonized by the invasive plant. The three types of plots were equally distributed over three mixed deciduous forest areas that were slightly, moderately or heavily affected by a wind throw 11 years ago. A total of 33 gastropod species were recorded. Gastropod species richness was not affected by delayed effects of the wind throw, but it was significantly higher in invaded plots than in plots in which *I. glandulifera* had been removed and in uninvaded plots. Similarly, gastropod abundance was higher in invaded plots than in the two types of control plots. Canonical correspondence analysis revealed slight shifts of gastropod communities between the three types of plots and indicated that soil moisture, density of *I. glandulifera* and cover of woody debris favoured gastropods. Field measurements showed that soil moisture was higher and daily soil temperature was more damped in patches of *I. glandulifera* than in the native ground vegetation. The changed microclimatic conditions may favour certain gastropod species. In particular, ubiquitous species and species with a high inundation tolerance increased in abundance in plots invaded by *I. glandulifera*. Our field experiment demonstrated that an invasive plant can indirectly affect native organisms by changing soil characteristics and microclimate.

P3 – Is UV-B adaptability an indicator for invasive potential?

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Intensity of ultraviolet-B radiation differs fundamentally between northern and southern hemispheres. In consequence, a large number of exotic plant species that originate from the northern hemisphere are exposed to higher amounts of UV-B when expanding into the southern hemisphere, such as in New Zealand. To assess the effects of UV-B on plant physiology and growth, and the potential role of the destructive radiation as an environmental selective filter during plant invasion in New Zealand we established a growth chamber experiment, using UV-B lamps and involving German and New Zealand populations of the biannual weed *Echium vulgare.* A similar study was conducted in New Zealand under ambient UV-B to confirm the previous results achieved in an artificial environment. Seeds of the widespread invaders *Echium vulgare* and *Verbascum thapsus*, and of two related species without a great invasive potential (*Echium plantagineum*, *Verbascum nigrum*) were exposed to UV-B radiation within an additional germination experiment. Results showed no evidence for better UV-B adaption in New Zealand populations of *Echium vulgare*. However, several effects of UV-B were observed regardless of origin, such as a decrease in belowground biomass and specific leaf area and an increase in leaf dry matter content and leaf hairiness. Apparently, the ability to respond quickly to UV stress is an important characteristic of species invading the southern hemisphere. This offers the potential of identifying future invaders by their specific set of traits that are linked to UV-B protection.

P4 – Importance of life-history traits for success and effects of introduced tree species

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Research on introduced, "invasive" plant species has traditionally focused on species with early successional life-history traits, especially annual or perennial grasses. For a long time forests have been considered resistant to invasions. But they are not. In fact there are many tree species proliferating outside their native ranges (e.g. *Trachycarpus fortunei* and *Cinnamomum glanduliferum* in the Ticino, Switzerland) and climate change is expected to induce further range shifts.
There are two main reasons why it has been difficult to predict the influence and success of introduced tree species. The first is that although late successional life-history traits seem to be important for non-native tree species to establish, there is still a lack of detailed knowledge about the relative importance of these. The second difficulty is that lifecycles in forests are too long to design and carry out experiments which promptly produce results.
In our study we therefore use the spatially-explicit, dynamic forest-landscape model *LandClim*. This allows us to introduce many artificial tree species into existing forests and evaluate the importance of their life-history traits and the prevailing ecosystem conditions for their success and for the effects they have on native species.

P5 – Age structure, dynamics and performance of native and invasive Salicaceae species on islands of the Río Negro, Patagonia

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The establishment of floodplain forests structured by invasive willows and poplars becomes a fast growing problem in Argentina. In the recent decades they have occupied large areas e.g. in the Río Negro region in northern Patagonia. However, there is an almost complete lack of knowledge regarding their major effects on the ecosystem in general, and more specifically the impact on the only native tree species, *S. humboldtiana*.
Therefore, we analysed age structure and growth performance of invasive and native Salicaceae to understand invasion history and future trends on islands along the Río Negro. Core samples of four different taxa (*Salix humboldtiana*, and the most dominant invasive species: two *Salix*-hybrids and *Populus* spec.) were taken in 20 mixed adult forest stands in order to detect possible differences in establishment history. In a second study, age was related to growth performance (length, basal area, DBH, height to crown base, crown diameter) in solitary trees of all 4 species and trees in mixed stands.
Trees of the same stand showed the same age structure indicating one single establishment event with native and invasive species involved. The detected low age of the stands suggests frequent and severe disturbances within the active zone of the Río Negro. Major floods may allow for the establishment of stands by removing existing vegetation or by creating new islands when sediments are deposited. However, plant performance of *S. humboldtiana* and *Populus* trees were significantly worse in comparison to invasive willow hybrids. Therefore, it can be assumed that *Salix* hybrids of Eurasian origin are capable to out-compete the native *S. humboldtiana* in many places along the Río Negro. Although

strong changes in the plant communities are noticed, it can be supposed that *S. humboltiana* can coexist with invasive willows, as long as natural disturbances remain for new establishment.

P6 – Assessment of hybridization and introgression between the native *Salix humboldtiana* and invasive *Salix* species at the Río Negro, Patagonia

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Hybridization and introgression are frequent in plants, especially among species of the genus Salix. These phenomena could be important evolutionary drivers. Disturbed habitats with formation of new ecological niches increase the probability of occurrence and successful establishment of hybrids. Evolution may proceed very rapidly when hybrids are at selective advantage. In the last decades, widespread invasion of introduced willow clones of the complex *Salix alba* - *Salix fragilis* and *Salix babylonica* can be observed along the Río Negro in north Patagonia, Argentina. There is a complete lack of knowledge whether hybridization and introgression between the native *Salix humboldtiana* (Willd.) and the introduced *Salix* taxa occur and whether they affect the evolutionary processes in *S. humboldtiana*. In order to analyze these processes more than 1500 *S. humboldtiana* and 300 exotic *Salix* adult individuals were sampled in 43 stands along the Río Negro valley and the lower valleys of Río Neuquén and Río Limay. Natural regeneration was sampled at 14 stands at the Río Negro and Río Neuquén summing up to 1344 individuals. Interspecific hybridization is tested through diagnostic genetic markers with one SSR marker being diagnostic for *S. humboldtiana*. Other SSR diagnostic markers are used to assess the taxonomic status of the complementary taxon involved in hybridization events. A preliminary analysis of a subset of individuals has shown fourfold more hybrids in the regeneration than in the adult life stage which could be a hint that hybridization and introgression is going to shape short-term evolutionary processes in *S. humboldiana* and that the integrity of the genetic pool of *S. humboldtiana* could be threatened by these processes.

Session 4 – Chemical Ecology

Chairs: Thomas Schmitt, Sara Leonhardt, Martin Kaltenpoth

O1 – Chemical defenses in floral scent and nectar: How to deter foes but still attract friends

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Floral scents and nectars are usually thought of as advertisements and rewards for pollinators. However, flowers are also visited by antagonists, such as nectar thieves, inefficient pollinators, herbivores and microbes. In recent years, some scent and nectar components have also been shown to defend flowers against such antagonists. Nevertheless, it is unclear whether defenses against floral enemies also deter genuine pollinators.

Floral scents are complex blends of volatiles, and it has been hypothesized that some constituents are attractive while others are deterrent. In *Phlox paniculata* flowers, we manipulated the levels of one group of volatiles, the terpenoids, with metabolic inhibitors and found that lower terpenoid emission resulted in reduced repellency to nectar-thieving ants (*Lasius niger*). However, the emission of repellent terpenoids had no effect on visitation by hoverflies (*Episyrphus balteatus*) and other potential pollinators.

As another example, we investigated the self-pollinating *Arabidopsis thaliana*, for which the major flower volatiles are terpenoids. Manipulation of terpenoid emission by genetic transformation demonstrated that these compounds reduce microbial (*Pseudomonas syringae*) growth, but do not affect flying insect visitation. Thus floral volatiles could serve as filters to discourage enemies, but not deter pollinators.

Nectars also contain toxins, such as phenolics or alkaloids, which appear to deter antagonistic visitors. Recently, we discovered that two species of bee-pollinated plants, *Tithonia diversifolia* and *Fagopyrum esculentum*, which contain phenolic deterrents, also endow their nectar with components of the *Apis* honeybee queen pheromone. The pheromone components were observed to override the deterrence of phenolics to foraging honey bees. By using pollinator pheromones in their nectar, these bee-pollinated plants maintain attraction of pollinators while at the same time defend against unwanted floral visitors. Thus flowers appear to be able to use their chemistry to simultaneously maximize interactions with pollinators and minimize encounters with antagonists.

O2 - Chemistries of resin stores and propolis of Australian stingless bees (*Tetragonula carbonaria*)

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Bee propolis is a mixture of plant resins collected by native bees, *Tetragonula carbonaria*, in subtropical Eastern Australia. Bees use propolis for buildng and chemical defence. Stingless bees store plant resins inside their nests, presumably for later incorporation into propolis. *T. carbonaria* propolis of unidentified botanical origin was previously reported. This study investigated the chemical variability of bee propolis from different botanical sites and resin deposits found in hive-managed *T. carbonaria* nests. Ethanolic extracts of hive-resins and propolis were subjected to Gas and Liquid Chromatography Mass Spectrometry coupled to Diode Array Detection for the separation, detection and identification of individual constituents. Fractionation and isolation of some components were undertaken by normal and reverse phase column chromatography, and characterisation by Nuclear Magnetic Resonance. Hive-resins were of different appearances, suggesting characteristic chemical profiles. Aims were to compare the chemical profiles and molecular fingerprinting across resin deposits, and overall propolis types. Four resin deposits were observed and labelled as the 'creamy', 'white', 'orange' and 'red' hive-resins. Several plant secondary metabolites were tentatively identified as substituted flavonoids, several isoprenoids and diterpenic esters, and some unknowns. The chemical complexity of bee propolis types suggested that bees incorporate several plant resins during propolis production, and possibly use the internal stores for resin provisioning. Compounds were found across resin-stores, while characteristic constituents were proposed as chemical markers for each resin type. Findings identified the fruit resin of *Corymbia torelliana* eucalypt tree as the source for the 'creamy' hive-deposit, while the botanical origins remain to be identified for the other hive-stores. This chemical work establishes the chemical variability of Australian *T. carbonaria* propolis.

O3 – Chemical ecology of insect parasitoids: essential elements for developing effective biological control programmes

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Insect parasitoids can find their hosts in complex environments and reproduce through a series of behavioural steps which are regulated mainly by chemical cues, termed semiochemicals. According to functional criteria, stimuli can be classified into four main categories: (A) cues coming from the habitat, the host microhabitat or the food plant, (B) direct host-related cues, (C) indirect host-related cues, and (D) cues coming from the parasitoid itself. In recent years, considerable progress has been made in elucidating the semiochemicals used by parasitoids to locate their hosts. Several studies provided interesting prospective for manipulating foraging behaviour of parasitoids in order to increase their impact on pest populations. However, most of the research has been conducted mainly under laboratory conditions, which differ considerably from field conditions, especially in agro-ecosystems in

which human activities modify the tritrophic interactions between plants, phytophagous insects, and parasitoids. As a consequence, it is often not known how to employ semiochemicals in the field to successfully manipulate parasitoids in order to improve their efficiency in biological control programs and the simple application of semiochemicals could be counter-productive. In order to provide essential elements for developing effective biological control programmes, we critically review recent research on different strategies to manipulate parasitoid behavior for the conservation or the recruitment of parasitoids within agro-ecosystems. We show where the complexity of the system should be consideredwhen accompanying the introduction and/or the conservation of natural enemy populations within agro-ecosystems by exploiting tritrophic interactions and manipulation of parasitoid behavioral responses to chemical cues.

O4 – Defense, sex and more – parsimonious use of semiochemicals in *Leptopilina heterotoma* (Figitidea, Hymenoptera), a parasitoid of *Drosophila*

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Chemical defense is probably the most common countermeasure of insects against a predator attack. Among the Hymenoptera, chemical defense is well known from social species such as ants or bees, but little is known about the chemical defense mechanisms of solitary Hymenoptera.
Leptopilina wasps (Figitidae, Hymenoptera) are solitary larval parasitoids of *Drosophila* flies. In this study we demonstrate, that females of *Leptopilina heterotoma* produce (-)-iridomyrmecin in a cephalic gland and release it upon encounter with potential predators. Bioassays show that iridomyrmecin has a strong repellent effect on ants and that (-)-iridomyrmecin has a stronger repellent effect than other stereoisomers of iridomyrmecin. Using headspace analyses we also show, that the wasps adjust the amount of iridomyrmecin released depending on the size of the predator.
Males of *L. heterotoma* produce only the less effective (+)-isoiridomyrmecin for defense. This suggests a second possible function of iridomyrmecin in the sexual communication of *Leptopilina*. In support of this hypothesis, we have now demonstrated that (-)-iridomyrmecin, in combination with some minor iridoid compounds, is an essential component of the female sex pheromone blend that attracts males and triggers courtship behavior.
Furthermore, preliminary data suggest that (-)-iridomyrmecin is also used by *L. heterotoma* females as a spacing pheromone to detect and avoid host patches which are already exploited by conspecific females.
The threefold function of (-)-iridomyrmecin in defence, sexual communication, and host patch selection is an excellent example demonstrating the economic use of costly chemical messengers by insects, commonly referred to as ‘semiochemical parsimony’.

- Journal of Chemical Ecology (2012) 38: 331-339

O5 - Chemical disguise of myrmecophilous cockroaches and its implications for understanding nestmate recognition mechanisms

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Cockroaches of the genus *Attaphila* are well known from within Atta colonies. They appear to feed on the fungus and disperse between colonies horizontally (via foraging trails) and vertically (attached to gynes on the mating flight). We collected cockroaches from colonies of *Atta colombica* and *Acromyrmex octospinosus* and describe their chemical strategies to integrate into host colonies. The cockroaches employ a mixed strategy of chemical insignificance (reduced cuticular hydrocarbon concentration) and mimicry (copying the host colony's odour). The comparative approach also allowed us test the U-present model, which states that a worker belonging to a social insect colony screens each encountered individual by looking for novel (undesirable) recognition cues that are not used by its nestmates, instead of checking whether the encountered labels match the colony odour. Cockroaches from *Acromyrmex* colonies bear lower amounts of cuticular substances and are thus less likely to be attacked by non-nestmate ants than cockroaches from *Atta* colonies: Due to their low concentration, the undesirable cues (non-nestmate specific substances) of cockroaches from *Acromyrmex* colonies are more likely to remain undetected by non-nestmates, while desirable cues (nestmate-specific substances) that are missing do not trigger aggression.

O6 – Nest sanitation and food hygiene in the Emerald Cockroach Wasp *Ampulex compressa* (Hymenoptera: Ampulicidae)

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In their ever ongoing struggle with competitive and pathogenic microorganisms all higher organisms have to deploy appropriate antimicrobial strategies to secure their survival and/or well-being. The insects, owing to their tremendous diversity and the plurality of their life-styles in all imaginable habitats provide manifold and promising opportunities for the study of antimicrobial defense mechanisms. Here we describe a hygienic behavior of the Emerald Cockroach Wasp *Ampulex compressa*. This wasp relies on cockroaches like the American cockroach *Periplaneta americana* as food for its progeny. The wasp larvae develop on and inside their cockroach hosts, which represent both their food and microenvironment. *P. americana* is known to harbor various and numerous microorganisms, including entomopathogenic strains that might threaten *A. compressa* larvae. We could show that in order defend themselves against these antagonistic microbes, *A. compressa* larvae impregnate their hosts with large amounts of an antimicrobial oral secretion. The two dominant chemical compounds in the larval secretion are mellein and micromolide. In bioassays mellein inhibited the growth of the gram-negative entomopathogen *Serratia marcescens*, micromolide was active against the gram-positive *Staphylococcus hygicus*. The larval secretion, containing the natural blend of mellein and micromolide, inhibited both bacteria and showed a higher activity against *S. hygicus* than micromolide alone, suggesting a complementary or even synergistic action of the two compounds. Our own results, together with several published data on the antimicrobial activity of mellein against bacteria, fungi, and a virus as well

as the activity of micromolide against mycobacteria suggest that the ecological function of the larval secretion is the protection of the developing wasp offspring against a wide range of putrefactive and pathogenic microbes.

O7 – *Streptomyces* symbionts guard their host's development with a stable broad-spectrum combination prophylaxis

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Philanthini digger wasp females ("beewolves"; Hymenoptera, Crabronidae) cultivate *Streptomyces* bacteria in specialized antennal gland reservoirs and secrete them into the subterranean brood cells, where the bacteria are taken up by the larvae and incorporated into their cocoons. On the cocoon of European beewolves (*Philanthus triangulum*), the symbionts have previously been found to produce a cocktail of nine antibiotic substances, comprising streptochlorin and eight different piericidine derivatives, which significantly reduce the risk of pathogen infestation for the beewolf offspring in the cocoon.
To shed light on the evolution of this antimicrobial cocktail, we sampled cocoons or female antennae of 21 beewolf species from three different genera across a wide range of geographic locations. Using LC-ESI-MS/MS, we analyzed the qualitative and quantitative composition of the antibiotic cocktails in the natural system. In several species, we found one new streptochlorin (SF2583A) derivative, 5 derivatives of the similar, but chlorine lacking compound SF2583B, the previously not described N-Acetyl-Glucosamine-Piericidines and Actinopyrones as well as Mer2026 A&B. Overall, however, the antibiotic cocktail both qualitatively and quantitatively shows a high level of conservation across species, with the possible exception of the most basal symbiont strain that exhibits considerable quantitative differences from all other strains. The high similarity across strains suggests that the beewolves' antibiotic cocktail provides a globally efficient and evolutionarily stable defense against a broad spectrum of potential antagonistic or pathogenic fungi. Thus, the symbiosis with antibiotic-producing bacteria may have represented an evolutionary key innovation that enabled beewolves to cope with the unpredictable community of microbial pathogens at diverse nesting sites and thereby allowed them to expand into new habitats.

O8 – With sex and toxins against predation - first insights into induced fungal defense strategies against antagonistic insects

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While inducible defense strategies are widely recognized in plants attacked by herbivorous insects, fungi, despite their tremendous importance in the decomposer food web, have largely been neglected. Direct fungivore resistance is mediated by chemical properties of fungal tissue, e.g. production of toxic secondary metabolites (mycotoxins). However, whether fungi control the synthesis of toxic metabolites in response to insect fungivory is unknown. We demonstrate that insect fungivory on *Aspergillus nidulans* induces a chemical phenotype that repels future fungivores and retards fungivore growth.We found a significant up-regulation of various SMs and key genes involved in SM synthesis in insect-challenged fungi, which coincided with the formation of sexual fruiting bodies that were better protected against fungivory than asexual structures.Our study demonstrates adaptive plasticity in the ability of *A. nidulans* to resist fungivory, and thus provides an ecological basis for how genetic programs linking secondary metabolism with reproductive development may facilitate fungal adaptation to predation.

O9 – Host plant and vector recognition in a phoretic flower mite

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Dispersal is fundamental to life. The evolutionary forces influencing emigration and immigration are quite well understood, at least from a theoretical point of view. Yet, the proximate cues used to actually make an appropriate and adaptive dispersal decision need further investigation.

The flower mite *Spadiseius calyptrogynae* is found in Neotropical lowland rainforests in Cost Rica. It exclusively inhabits inflorescences of the understorey palm *Calyptrogyne ghiesbreghtiana* and is phoretic on a number of flower visitors including bats (*Artibeus* spp.), a stringless bee species (*Trigona fulviventris*) and two species of coleopterans. We analyse information use in the context of dispersal using the animal-plant interaction between this phoretic flower mite, its host plant and its phoretic vectors.

On the one hand, the mites should be choosy with respect to potential phoretic vectors since not all flower visitors fly appropriately long distances or may not revisit the host plant species. On the other hand, since all flower visitors are generalists we hypothesise that habitat discrimination is important for immigration.

Using a basic olfactometer setup we are able to show that *Spadiseius* flower mites discriminate between host and non-host plants. Furthermore, we found evidence that non-volatile components allow the mites to determine inflorescence age, which is an important cue that induces emigration.

Besides host plant recognition the flower mites are also able to identify high-quality phoretic vectors from cuticular components. Scent cues collected from highly non-mobile flower visitors even acted as repellents. In general, our results suggest that the mites have a preference for the stingless *Trigona* bees as phoretic vectors.
This field study is the first we are aware of to analyse olfactory orientation in a flower mite. In addition, we present simulation results that allow us to pinpoint the evolutionary forces responsible for the observed patterns of phoretic vector choice.

O10 – Sugars and amino acid composition in nectar of two plant species along a plant diversity gradient

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Nectar is a liquid solution produced by flowering plants, containing sugars and amino acids which are essential nutrients for flower visitors. Both plants and their interacting flower visitors are under high pressure to maximize their fitness for reproduction. Plants further compete for resources with individuals of the same or other species. How efficiently a plant species allocates resources into pollen and nectar may consequently depend on the presence, identity and diversity of surrounding plant species. If different plant species compete for the same pollinators, they may allocate more or even different sugars and amino acids into their nectar, thus rendering it more attractive for pollinators.
We investigated the chemical composition of nectar of *Geranium pratense* and *Knautia arvensis* along a plant diversity gradient of 1, 4, 8 and 16 species. For each plant species the experiment was carried out in 4 field plots, each plot representing one of the species richness levels, in the Jena Experiment (Jena, Germany) and samples were taken from the core area (21 m^2). Both study species are frequently visited by bees and other insect taxa. To evaluate differences in the amino acid- and sugar-composition, nectar was sampled from ten plant individuals per plant species per plot between August and September 2010 and analyzed via high performance liquid chromatography (HPLC). Preliminary results show differences in compositional patterns of amino acids between monoculture and 16 plant species mixture. We plan to further investigate if and how plant diversity and other plant community attributes drive changes in nectar quality and if differences in nectar quality can explain flower visitation patterns.

O11 – Interaction between the leopard moth borer and olive varieties: Associational Resistance at work

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In the last few decades, The leopard moth, *Zeuzera pyrina* L. (Lepidoptera: Cossidae) became wide spread in newly established olive orchards in Egypt, where it causes damages and decreases plant vigour and may cause plant death. Its larvae are woodborers affecting a wide variety of trees and shrubs. Newly established olive orchards suffered the greatest damage, including the death of young trees. In Egypt, damage caused by leopard moth led to uprooting some olive groves. Field data show clear differences in number of active galleries/tree and number of broken olive shoots among varieties, while laboratory rearing experiments show strong differences in suitability for larval development. The varietal sensitivity of olive trees, based on a plantation of mixed cultivars in ratio of 1:1 in rows of 3+3 on ~900 tree plots, could be summarized as follows:

1. Some olive varieties were much less injured (Shamy, Kalamata, and Dolcie) than others (Hamed, Toffahi, and Sennara), showing variation in resistance.
2. Development (survival, growth) of artificially infested larvae (no-choice test) within shoots took place successfully only in same varieties (e.g. Toffahi and Sennara), showing strict sense resistance to feeding
3. Contrary to expectations, surface wash and volatile collections in situ, analysed by GC and GC-MS, both showed that in terms of major peaks of released volatiles, the more resistant variety showed fewer and smaller peaks
4. Susceptible varieties like Toffahi growing together in a plot with resistant cultivars (e.g. Shamy) tended to have lower attack densities, showing Associational Resistance (AR) at work.
5. The mechanism(s) of the observed AR are as yet not known, but may include both a strict sense Resistance of some cultivars-giving a lower Resource Concentration, and a Semiochemical Diversity – giving reduced search efficiency in pre- or post-landing host selection or possibly habitat selection, or a reduced chemical appearance of the resistant variety.

P1 – Fungivore foraging strategies are driven by fungal chemical defense

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Aggregative behavior in fungivorous soil arthropods is widespread; its adaptive value, however, is largely unknown. We investigated the spatial foraging behavior of a collembolan, *Folsomia candida*, and the fitness consequences of feeding at different densities on the filamentous fungus *Aspergillus nidulans*. We compared the effect of two fungal strains, a wild type and a transgenic strain that lacks the ability to express the global secondary metabolite regulator LaeA. In laboratory foraging tests, *F. candida* exhibited aggregated distributions of individuals across four distinct fungal colonies that were arranged in short distances from each other. By quantifying the extent of the feeding damage at each single colony, we found a more evenly distributed feeding activity among wt colonies than among chemical deficient colonies. In a fitness experiment, where collembolans at different densities were restricted to feed on single *A. nidulans* colonies, mean growth rate of *F. candida* was positively related to density on the wt *A. nidulans* strain, but negatively related to density on the chemical deficient strain. Depending on the fungus' ability to express secondary chemicals and availability of fungal food sources, *F. candida* may employ different foraging strategies: [1] avoidance of prolonged feeding on single colonies in a rich habitat (travel costs are low), [2] intensified group-feeding on single colonies in a resource-limited habitat (travel costs are high). We hypothesize that flexibility in fungivore foraging behavior (clumping vs. spreading feeding activity) is adaptive because it allows avoidance/overcoming induced fungal chemical defense.

P2 – Visiting communities of extrafloral nectaries in a subtropical Chinese forest

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Extrafloral nectaries (EFNs) are found in a wide range of plant species, particularly in the tropics and subtropics. Extrafloral nectar (EF) attracts a diverse community of consuming insects. Particularly ants are well known to feed on EF. Up to now, only few studies compared diversity, abundance and structure of visiting communities between different plant species bearing EFN.
We observed the overall insect community visiting EFN of five tree species in an early successional subtropical forest in South-East China from April to June 2012. The field sites are part of the BEF-China tree biodiversity experiment. Altogether, 224 hours of observation time, 140 minutes for every of the 96 trees, revealed a diverse insect community, with over 50 species visiting EFNs. In general, ants made up about 70% of individuals, but a high species diversity of Diptera, Coleoptera, and other Hymenoptera were also visiting EFNs. There were profound differences in the visiting communities between the tree species, both in abundance, diversity and community composition.
We are currently analysing if these insect community responses are mainly driven by morphological traits or the composition of various sugars and amino acids of the EF. Our results will help to answer the question what traits structure visiting communities on EFN plants in general.

P3 - Different responses of ant species to sugars and amino acids in a subtropical forest of China

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Vegetation-foraging ants are common consumers of liquid food sources such as honeydew and nectar. These food sources contain mainly sugars but also various amino acids. Studies testing which of the compound groups influence the ants feeding preferences are scarce. In the present study, we focus on the nutritional preferences of nectar foraging ants in an early successional subtropical Chinese forest. The field sites are part of the BEF-China tree biodiversity experiment. We investigated which sugars were preferred by different ant species and whether amino acids influenced ant abundance and feeding behaviour. Therefore we established choice tests comprising two experiments on the tree *Schima suberba* (Theaceae). In the first experiment, we offered 11 different sugar-solutions. In the second experiment, we supplemented each of the four most preferred sugars with the 10 essential and the 10 non-essential amino acids. Most ant species preferred sucrose, glucose, fructose and melezitose over the other sugars. Especially sucrose and melezitose that are common components in aphid honeydew provoked high ant-attendance. Furthermore, ants preferred solutions containing amino acids. Altogether, our results show that various sugars known from natural nectar and honeydew are consumed by nectar-foraging ants while others are neglected. Amino acids act as important nitrogen source and positively influence the ants' foraging behaviour. These results are consistent with the hypothesis that amino acids in nectar and honeydew improve the mutualistic service by ants against natural enemies, as anti-herbivore defense for plants and anti-predator defence for aphids.

Session 5 – Coastal and estuarine ecosystems

Chairs: Antonia Wanner, Veit Hennig, Kai Jensen

O1 - Does prescribed burning result in biotic homogenization of coastal heathlands?

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Biotic homogenisation due to replacement of native biodiversity by a few widespread generalist species has been demonstrated in a number of ecosystems and taxonomic groups world-wide, and causes growing conservation concern. Human disturbance is one of the key drivers of biotic homogenisation, suggesting potential conservation challenges in semi-natural ecosystems and cultural landscapes, where anthropogenic disturbances such as grazing and burning are necessary tools for maintaining the dynamics and functioning of the ecosystem. In this study we test whether fire disturbance results in biotic homogenisation in the coastal heathlands of north-western Europe, a semi-natural landscape where extensive grazing and burning are parts of the traditional land-use dating back 6000 years. We compare the beta-diversity before and after fire at three spatial scales; within local vegetation patches, between wet and dry heathland patches in the same landscapes, and along a 470 km bioclimatic gradient. After fire we recorded increased species richness, and the species that entered the burnt *Calluna*-stands were mainly native grasses and herbs characteristic of the heathland system. Species that increased after fire generally had narrower geographic distributions than the pre-fire flora, resulting in differentiation after fire, rather than homogenisation, within patches and along the bioclimatic gradient. At the landscape scale, however, the dry and wet heathland patches became more compositionally similar after fire. This was related to a decrease of species that were specific to wet or dry habitats, which were replaced by post-fire specialists that established in both habitat types. Our study demonstrated that scale matters when studying homogenization.

O2 – Scale matters: Impact of grazing regime on plant diversity in salt marshes at the German Wadden Sea coast

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After the Wadden Sea National Park of Schleswig-Holstein was established in 1985, intensive sheep grazing was abandoned on many salt marshes. Consequently, structure, species composition and

diversity of vegetation changed. In many areas, vegetation diversity increased whereas in others, highly competitive species (e.g. *Elymus athericus*) developed monodominant stands of low diversity.
Using long-term monitoring data of the National Park, we addressed the following questions:

- Does species and vegetation type diversity differ between intensively, moderately and ungrazed salt marshes?
- Does the impact of grazing regime on diversity differ between spatial scales from 0.01 m² up to 1 ha?
- How has diversity developed over time?

We analysed differences in species richness and evenness between intensively, moderately and ungrazed permanent plots of 4 m² in 1992 and 2010. Species-area-relationships were analysed in 2011 in all grazing regimes using a design of nested plots from 0.01 to 100 m². For both analyses, data was separated into low and high salt marsh.
To compare large-scale diversity between 1988 and 2006, we used vegetation type maps on a scale of 1:5000 according to the classification of the Trilateral Monitoring and Assessment Programme. For 1 ha-plots homogeneous in grazing regime, the number and evenness of vegetation types was calculated in a Geographic Information System, taking the distribution of pioneer, low and high marsh into account.
Species richness on 4 m² has increased since 1992 in all grazing regimes, while evenness has decreased. This effect was more pronounced in the low marsh than in the high marsh. In 2010, intensively grazed plots had slightly higher species richness than ungrazed or moderately grazed plots. Differences in species richness between grazing regimes decreased with increasing spatial scale.
Also vegetation type richness has strongly increased between 1988 and 2006 in all grazing regimes. In 1988, ungrazed low and high marshes had a higher richness than intensively grazed marshes. In 2006, this difference was only found in low marshes.
It is concluded that management effects on salt marsh vegetation diversity differ in respect to spatial scales and low and high marsh.

O3 – Effects of raised temperature and northward species migration on tidal freshwater marsh communities from European and North American estuaries

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Tidal freshwater marshes are known to be potentially vulnerable to climate change as their species diversity might be negatively affected by sea level rise and accompanied salt water intrusion. Further, increased temperatures might lead to the dominance of highly competitive species and reduce biodiversity. Possible compensating effects of northward species migration on these climate change consequences have not been investigated yet. Here we analyze how an increase in temperature and a northward migration of tidal freshwater species affect biomass production and diversity pattern of experimental marsh communities. In February and March 2011, we sampled soil seed banks from each of three estuaries in the temperate zone in Europe and North America. In each estuary, three sites were sampled. To get a composite soil sample from each estuary, one third of each of the soil samples from each site was mixed. To mimic northward species migration, soil samples from the different estuaries within each continent were also mixed. Subsamples of these composite samples were exposed to two temperature regimes (ambient, increased) between May and October 2011. We recorded germination

in May and June 2011. Final aboveground biomass of all occurring species was harvested in October 2011.
The number of species per tray was similar between the continents, while biomass production was lower in European than in American samples. In both continents, the samples with the lowest aboveground biomass were those from the northernmost estuary. The highest number of species occurred in the samples from the southernmost estuaries. Increased temperature significantly increased biomass production of forbs in the European samples, and forbs and grasses in the American samples. Furthermore, increased temperature tended to reduce the number of species per tray. Finally, northward species migration significantly increased the number of species in both American and European samples. We conclude that increased temperatures might lead to an increase of aboveground biomass production in tidal freshwater marshes. Without northward species migration, this might lead to reduced species diversity. These negative effects might be compensated if northward species migration is possible to occur along the shorelines of both sides of the Atlantic Ocean.

O4 - Macroinvertebrate communities and diversity of brackish, ephemeral water bodies at the coast of Northern Germany

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The Lower Saxony Wadden Sea National Park is a biodiversity hotspot. Water bodies of different salinities and habitat duration are colonised by diverse macroinvertebrate communities. However, previous studies did not investigate episodic or intermittent aquatic habitats. Our study aimed to evaluate the colonization patterns and biodiversity of those mostly neglected water bodies.
On the East Frisian Island of Baltrum, 164 brackish, ephemeral pools and ditches were controlled approximately every two weeks between April and June 2010. Macroinvertebrates were collected with a 500 µmm mesh net. Every sampling date the flooded area was estimated, maximum depth, pH, temperature, conductivity, and salinity of each water were measured. Habitat duration was recorded as number of sampling dates with water present.
Site-based rarefaction curves were used for species richness comparison. Alpha diversity was evaluated with Simpson- and Shannon-indices. Additionally, we calculated the non-parametric estimators Jack2 and Chao2. Jaccard and Sørenson similarity indices adapted from Chao et al. (2005) were used to measure beta diversity. Species composition were analysed with a cluster analysis with UPGMA clustering method and Bray-Curtis distance. Additionally, Non-Metric Multidimensional Scaling (NMDS) using Bray-Curtis distance was used to evaluate dispersion of species composition and their relation to physico-chemical variables.
A total of 19,239 individuals had been collected and identified. We recorded a total of 61 species and higher taxa (including the taxon Chordata), but 12 taxa only with one individual. The salt-adapted mosquito species *Ochlerotatus detritus* (Haliday, 1833) dominated nearly all water bodies. Furthermore, especially different species of the order Coleoptera with highest densities for the family Dytiscidae colonized these pools. Hydrological parameters (permanence of the aquatic habitat, area and depth) were the most important determinants of species composition and alpha-diversity. Salinity only had a minor, but a significant impact within the salinity gradient of the study area. Beta-diversity was low, which might have been caused by a strong impact of regular desiccation events. Our study

demonstrated, that brackish, ephemeral water bodies on the East Frisian Islands have different hydrological conditions and salinities, resulting in different, diverse species compositions. Additionally, the occurrence of vulnerable species, e.g., the endangered aquatic beetle *Ochthebius viridis* PEYRON, 1858 (present in 25% of the studied water bodies) highlights the value of brackish, ephemeral water bodies in coastal areas.

O5 – Modelling biota-mud Interactions

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Although sediment dynamics is mainly driven by hydrodynamic forcing, biotic engineering of the sediments can significantly affect the outcome of physical interactions. The development of long-term, large-scale morphodynamic models must therefore be associated with semi-empirical information about the spatial distribution of benthic species and with process-based models of the biotic influence on sediment behavior.

The ecological literature describes many examples of the influence of benthic biota (microphytobenthos, benthic animals) on the geomechanical properties of intertidal sediments. The reverse process, namely how mud content of sediments influences the composition of the biological community, is also well known from a descriptive point of view, but generalizations are rare or absent.

Here, the influence of mud content on benthic communities is investigated through the (statistical) analysis of a large macrobenthic dataset. Quantile regression was used to account for realized species abundances distributions typically showed heterogeneity in variance and non-linearity along the sediment texture gradient.

This framework has been further extended with a series of flume experiments aimed to convert the observed patterns in specific abundances in modeled effects on sediment dynamics. The final aim is to include the biotic influences into existing morphodynamic models, increasing accuracy in biologic and fluvial engineering future scenarios predictions. This project is part of the innovative program Building with Nature (www.ecoshape.nl).

O6 – Migration patterns of juvenile twaite shad in the Elbe estuary

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Although being highly human-impacted, the Elbe is one of few remaining rivers in Europe harbouring a strong twaite shad *Alosa fallax* population. Juveniles hatch in the estuary and use nursery habitats in side-channels until the onset of their downstream migration. The migration behaviour of juvenile twaite shad in the Elbe estuary was investigated using otolith Sr:Ca and Ba:Ca ratios for the first time.
Samples of 17 adult twaite shad were collected in the Elbe estuary between Cuxhaven and Hamburg. One otolith per individual was extracted and ground to expose the core. For each otolith, laser ablation inductively coupled plasma mass spectrometry analysis was performed from the otolith core to the first annulus along a defined transect in order to determine otolith Sr:Ca and Ba:Ca ratios.
Juveniles exhibited two basic migration patterns with different numbers of estuarine passages, which demonstrates intrapopulation plasticity. However, all individuals initially stayed in areas of low salinity or freshwater indicating the importance of these habitats for development. Conservation implications of these findings are discussed.

P1 – Post -fire successions along a 390 km latitudinal gradient in Northern *Calluna* heathlands

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Coastal heathlands are semi-natural habitats managed through prescribed burning and/or grazing. Today, the heathlands are classified as greatly endangered, and abandonment of traditional heathland farming is a major threat. In this study we quantify the effect of geography on post-fire successions after experimental fires set in five coastal heaths along a north-south gradient in Norway. We assess whether the post-fire succession differs among sites along the gradient and question how habitat (wet/dry) influences the post-fire development along the gradient. A repeated measurements design was used, with floristic data recorded in wet and dry heath in permanent plots in the post-fire succession (n = 20) over a 3-year period. The data were analysed using multivariate ordination techniques and mixed effects models. Our study demonstrates that geography strongly influenced the post-fire succession; geography alone explained 27.4% of the total floristic variation in the dataset. The post-fire successional trend explained 17.4%, and out of this the geography-specific fire responses explained 6.5% of the variation. The regeneration rate in the south appeared faster than in the north, which might be explained by species composition and productivity related to climate. The wet habitats also showed a faster regeneration towards the pre-burned community than the dry habitats along the entire geographic gradient. This is probably linked to early-successional dry heaths harbouring a higher diversity and abundance of pioneer grasses and herbs than the wet habitats. In a conservation perspective, this study illustrates that heathlands vary geographically, not only in species compositions but also in post-fire

successional trends and dynamics. This study points to the importance of conservation of a geographically diverse set of sites, as well as the development of site-specific management plans.

P2 – Seed arrival and survival of salt marsh pioneer species on the intertidal mudflat: bottlenecks for seedling establishment?

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Salt marshes are valuable ecosystems for both their ecological function and their coastal protection capacity. These ecosystems are however being threatened by increasing anthropogenic impact worldwide as well as by sea-level rise. Conservation and restoration of these ecosystems is of great importance and deep knowledge on essential factors and processes determining their (re-) establishment is required, while mechanisms underlying seedling establishment of pioneer species in salt marshes are still poorly understood. Although seed arrival has no guarantee of seedling establishment, seedling establishment could not occur without seed arrival and survival at suitable site. In this study, Astroturf mats were employed to investigate patterns of seed deposition of *Spartina anglica* on the intertidal mudflat at two contrasting marshes (sheltered and exposed) in the Western Scheldt, the Netherlands, where seed survival patterns were determined through artificial seed bank experiments with colored seeds and mimics placed on the surface and buried at different depths (0.5 cm, 1.5 cm, 3.0 cm) and recovered monthly from January to June 2012. Meanwhile, the patterns of natural soil seed bank were also surveyed by sieving sediment samples (25 cm*50 cm*4 cm). Our results showed that at both field sites seeds tended to deposit close to the marsh (source area) with much more seeds deposited at 5 meters to the marsh than those at 25 meters and 45 meters. The artificial seed bank experiment showed that there was no significant difference between survivorships of seeds and mimics, indicating that no seed predation occurred during this experiment. Once deposited, most of the surface seeds were washed away by the tidal water with a very low survivorship (less than 20% on average) accounting for the small size of soil seed bank. In contrast, the survivorships of seeds buried in the sediments were much higher and increased logarithmically with their burial depths, highlighting the relevance of being incorporated into soil seed bank in time. Low survival of surface seeds at all sites and low seed deposition at sites far from seed source could be bottlenecks limiting seed bank sizes and thus decrease the colonization potential by seedling establishment.

P3 – Benthic foraminifera as indicator of ecological quality of coastal marine systems

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The implementation of environmental protection legislation is generating a fruitful debate amongst marine scientists about how to define efficient and reliable bio-assessment tools to monitor the ecological quality status (EcoQS) of marine waters. According to this legislation, EcoQS assessment

needs a "reference condition" with which to compare the present-day condition at a site. The fossil record has a potential to reconstruct PaleoEcoQS and thereby establish *in situ* reference conditions from pre-impact times. Unlike most macrofauna, the most commonly used biological quality indicator in these environments, benthic foraminifera leave a fossil record and therefore allow the reconstruction of human-induced environmental disturbance over decades to centuries. Foraminifera therefore have the potential to serve as ecosystem characterization tools in modern and past marine environments.
We compared the response of benthic foraminifera and macrofauna to selected environmental variables at sites with relatively similar salinity and temperature conditions but varying degrees of anthropogenic impact. In August 2008, replicate samples for living (stained) benthic foraminifera and macrofauna from 27 stations in 11 silled fjords along the Norwegian Skagerrak coast were collected. Environmental data (bottom-water dissolved-oxygen, TOC, TN and pigments) were analysed for each station. We find a strong relationship between foraminifera community composition and diversity and oxygen concentrations. Using these relationships, we estimate PaleoEcoQS for the past century from fossil benthic foraminifera in sediment cores collected from 11 stations in the inner Oslofjord.
Our results show that living benthic foraminifera are at least as reliable to define present-day EcoQS as macrofauna. Fossil benthic foraminifera can also define ecological status of reference conditions from pre-impacted times, which is not possible using macrofauna. Consequently, benthic foraminifera are excellent bioindicators of human-induced environmental impacts over time.

P4 – Twaite shad migration and spawning - new insights from the Elbe estuary

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Twaite shad *Alosa fallax* (Lacépède, 1803) is an anadromous species that has been included into Annexes II and V of the European Community Habitats Directive. To ensure the conservation of this species, the fundamental characteristics of its life strategy must be understood. Therefore, this study aims to determine aspects of its spawning migration, the spawning period as well as the location of the spawning areas in the Elbe estuary, Germany.
Twaite shad was sampled between Cuxhaven and Hamburg in three different areas of the Elbe estuary (lower, middle, upper part) by monthly research fisheries in 2010. Salinity in the lower part was below 10, in the middle part below 1 and in the upper part below 0.5. Additional samples were obtained from the cooling water intake of the Brokdorf Nuclear Power Plant. Spawning period and spawning areas were identified by investigating the maturity stage and the gonadosomatic index (GSI).
Overall sex ratio differed from 1:1 and was clearly shifted to the males indicating a predominance of males in the estuary. This was constant throughout the study period, but sex ratio differed spatially. Spawning took place from the end of April until the beginning of July at the most. Spawning areas were mainly situated in the middle and upper parts of the study area with salinities below 1.0.
These results revealed differences in migration behaviour of males and females in the Elbe estuary. These new insights into spawning period and current spawning areas provide a basis in order to develop efficient protection measures for twaite shad in the future.

Session 6 – Conservation in human-dominated landscapes

Chairs: Nina Farwig, Tim Diekötter

O1 – Expanding the debate on food and biodiversity

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To harmonise agricultural production and biodiversity conservation, two contrasting strategies have been proposed: land sharing versus land sparing. Land sharing integrates conservation and production at a fine scale, whereas land sparing fully separates land used for commodity production from land used for biodiversity conservation. I discuss eight points regularly missed in the debate about land sparing versus land sharing. One, whether researchers favour land sparing or land sharing is largely dependent on underlying paradigms. Two, in many instances, a combination of land sparing and land sharing is sensible. Three, sustainable resource governance requires a sound understanding of social-ecological complexities. Hence, four, framing the challenge of sustainable food production solely around yields and areas required to produce those yields is simplistic. Five, 'sustainable intensification' and ‘closing of yield gaps’ (auxiliary strategies to land sparing) promise cost-free gains and thus have obvious political appeal. However, six, a focus on optimising the efficiency of commodity production has undermined resilience in other systems, such as forestry. Seven, 'sustainable intensification' emphasises technological adaptation and thus implicitly downplays the need for behavioural adaptation. Eight, sustainability does demand major changes in human behaviour, including in relation to food and its distribution. I conclude that ecologists should carefully scrutinise to what extent simple conceptual models can be reliably used to address complex real-world problems. Key challenges routinely brushed aside are issues related to dietary change, food waste, and equitable sharing of food. The debate on land sparing versus land sharing urgently needs to be expanded to reflect the magnitude and complexity of the challenge of truly sustainable food production.

O2 – Sustainable Land Use in Central Romania

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Conservation in human dominated landscapes is a challenging task all over the world. Pursuing conservation targets often collides with the desire for economic development or is hampered by social conflicts, especially in poorer countries. More than ever, we need to understand and concert ecological, social and economic needs to facilitate sustainable land use in the future. Here, we present a transdisciplinary research agenda to foster sustainable development in Central Romania. Central Romania has an exceptionally rich cultural and natural heritage. Traditional agricultural practices without the use of agro-chemicals and machinery have maintained a highly heterogeneous landscape that supports an unusually high biodiversity. Following its recent inclusion in the European Union,

Central Romania now faces the balancing act between the aspirations of local people for prosperity and the region's unique heritage values. As part of our project, we map biodiversity, assess ecosystem services and identify formal and informal institutions that can provide leverage points for enabling sustainable land use practices. Against the background of our study system, we discuss key challenges for conservation and sustainable development and highlight avenues for how they may be overcome.

O3 – The costs and benefits of farming in organic and conventional agriculture

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Agricultural land serves multiple societal purposes; it provides food, fuel and fibre and acts as habitat for organisms and supports the services they provide. Biodiversity conservation and food production need to be balanced: production needs to be sustainable, whilst conservation cannot be totally at the expense of crop yield.

In order to identify the benefits (in terms of biodiversity conservation) and costs (in terms of reduction in yields) of agricultural management, we examined the relationship between crop yield and the species density and abundance of important taxa in winter cereal fields on paired organic and conventional farms in lowland England.

Out of eight species groups, five (farmland plants, epigeal arthropods, solitary bees, bumblebees and butterflies) were negatively associated with crop yield but the shape of this relationship varied between taxa. It was linear for the abundance of bumblebees and species density of butterflies, concave up for the abundance of epigeal arthropods and butterflies and concave down for species density of plants and bumblebees. Organic farming created a considerable premium in species density of plants at medium-to-low yields. However, at higher yields, species density in organic fields was not different from that in conventional fields.

Grain production per unit area was 54% lower in organic compared with conventional fields. When controlling for yield, farm management (organic vs. conventional) made a relatively small difference to overall biodiversity.

Our results indicate that considerable gains in biodiversity require considerable reductions in yield in highly productive agricultural systems. They suggest that conservation efforts may be more cost effective in low productivity agricultural systems or on non-agricultural land. In less productive agricultural landscapes, biodiversity benefit can be gained by concentrating organic farms into hotspots without a commensurate reduction in yield.

O4 – Controlling the toxic grassland plant *Colchicum autumnale* with minimal negative impact on plant biodiversity

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The toxic grassland species *Colchicum autumnale* reaches very high population densities in extensively managed grasslands in some regions of Austria and Germany. Farmers have difficulties to market or use their hay. Consequently, these grasslands are at risk of intensification or abandonment. The goal of our study (2008-11) was to find management measures that reduce *C. autumnale* populations and minimize negative impacts on plant biodiversity. We applied four different management regimes per country in seven Austrian and nine German *C. autumnale* populations. Within 1m^2 plots, *C. autumnale* individuals were recorded every year and assigned to the life stage seedling, small, medium or large vegetative, generative or dormant plant. In addition, vegetation composition of the plots was monitored. We analysed data on *C. autumnale* with matrix population models and calculated the population growth rate (λ). The contribution of different demographic processes to the difference in λ ($\Delta\lambda$) between treatments and the control were determined by life-table response experiments (LTRE). Survival and the probability of capsule production were compared using ANOVA and MANOVA. Vegetation data were analysed with multivariate methods. The early mown treatments (EMT; first cut in late April or early May) resulted in the lowest λ in all transition periods, and the lowest overall λ of 0.7. According to the LTRE, negative growth and positive regression accounted for the largest proportion of $\Delta\lambda$ in the EMT. Survival and capsule production were also lowest in the EMT. Due to the short study period, no striking changes in vegetation composition or diversity could be observed. According to this study, mowing in late April/early May reduces *C. autumnale* populations most effectively with small negative impact on plant biodiversity after 3 years. Anyway, in the long term, the requirements of nature conservation relevant species have to be considered in order to prevent biodiversity loss.

O5 – Effects of invasive plants and human land-use on plant-pollinator and plant-disperser networks

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The continuing spread of alien invasive plants and increasing human land-use are two major drivers of global change worldwide. They threaten species, interactions and ecosystems. Changes in mutualistic interactions can affect plant visitation and species' specialisations, with possible negative consequences for native plant reproduction and specialised plant-animal interactions. In a subtropical landscape in South Africa, we studied 17 plant-pollinator and 9 plant-disperser networks in the face of relative invasive plant abundance and human land-use intensity. Pollinators visited native plants more often than invasive plants but visitation rates did not differ for seed dispersers. Pollinator visitation to the overall plant community increased with land-use. Contrastingly, disperser visitation decreased with

invasive abundance. Pollinator visitation to native plants did not vary with invasive abundance, but disperser visitation decreased. Pollinator and disperser visitation to invasive plants did not differ along the two gradients. Overall pollinator specialisation on plants decreased with invasive abundance, whereas dispersers foraged generalised and unaffected by both gradients. Similarly, plant specialisation on pollinators decreased with land-use but was not affected in the dispersal networks. Our results show contrasting effects of plant invasion and human land-use on the community structure of plant-pollinator and plant-disperser networks. Pollinators appear to favour native plants over invasives, whereas dispersers forage regardless of plant origin. Specialised plants that depend on specific pollinators may only successfully reproduce in areas with high amount of natural habitat. While pollination of native plants is maintained by more generalised pollinators, native plant dispersal is reduced in invaded sites. We conclude that plant invasion and human land-use negatively affect specialised plant-pollinator relationships and that native plant reproduction could suffer from reduced dispersal in highly invaded habitats.

O6 – Effects of agricultural intensification in grasslands differ between wild bee species groups and geographical regions

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Wild bees are important pollinators of wild plants and major crops. Their decline is mainly caused by agricultural intensification, which reduces floral and nesting resources locally and causes habitat loss and fragmentation on a landscape scale. Few studies investigated effects of agricultural intensification on wild bees in extensively and intensively managed grasslands. Even less studies assessed how effects of agricultural intensification differ between geographical regions. However managed grasslands potentially provide essential wild bee resources and regional differences in species pools, landscape compositions and soil conditions could cause considerable variation in wild bee responses.
We recorded wild bees on 93 plots along a land use intensity gradient, using the framework of the Biodiversity Exploratories (http://www.biodiversity-exploratories.de/). We tested the effects of local habitat quality (flower cover), local land use intensity and landscape composition (percentage of bee habitat, forest and grassland) on wild bee abundance, looking for differences between two species groups (*Bombus* and non-*Bombus*) and three spatially separated study regions.
We found no differences in responses to local habitat quality and percentage of bee habitat. Responses differed between species groups for local land use intensity and between species groups and region for percentage of forest and grassland. Differences between species groups are probably due to differing foraging ranges and other life history traits. Regional differences could result from differing landscape compositions, type of semi-natural habitats and soil conditions.
Since regional characteristics influence species compositions and species groups react differently to agricultural intensification, an integration of regional differences could be crucial for successful conservation measures of wild bees in managed grasslands.

O7 – Habitat and landscape affects diversity of different traits of wild bees in contrasting ways

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Wild bees are essential for important ecosystem services like pollination and hence for the stability of many ecosystems. Land-use intensification and loss of semi-natural habitats have induced a severe decline of bee diversity in agricultural landscapes. Semi-natural habitats like calcareous grasslands are one of the most important bee habitats in central Europe, but they are often highly fragmented. In this study we tested the importance of habitat and landscape characteristics for the diversity of wild bees in calcareous grasslands. Species richness and abundance of wild bees were surveyed on calcareous grassland patches of different area and habitat connectivity.

We found that grassland area had a positive effect on overall species diversity of habitat specialists and generalists. Steep slopes as a qualitative patch factor had a positive effect on habitat specialists, whereas habitat generalists were positively affected by landscape patchiness and surprisingly, negatively affected by habitat connectivity. In contrast, bumble bee diversity was mainly driven by the amount of semi-natural habitats and benefited from high proportions of these. Our results emphasize a strong dependence of habitat specialists on the local characteristics of habitat patches, whereas generalists are more likely affected by the surrounding landscape. We conclude that large high quality patches are essential for the conservation of diverse bee communities in calcareous grasslands, but as generalists represent the majority of bee species, highly structured landscapes are also important to provide crucial ecosystem services like pollination.

O8 – Resource use and competition between honey bees and wild bees in the Lüneburger Heath

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For many years nature conservationists and bee keepers have been debating about the possible competition between managed honey bees and wild bees. The nature conservationists are concerned that honey bees outcompete wild bees by depleting foraging resources. In the Lüneburger Heath region, however, beekeeping has a long tradition. The overarching goal of our study was to investigate if honey bees reduce flower visitation rates and reproductive success of stem-nesting wild bees in the Lüneburger Heath.

Therefore we conducted two field experiments in 2011 in the Lüneburger Heath region of Lower Saxony, Germany. Nine heath land areas were selected whereby five contained honey bee hives whilst the other four were at least 500 m away from the next hive. In each area four plots were established at different distances from the honey bee hives (5, 50, 100, 150 m) or from a random point in the four areas without honey bee hives. In the first experiment we observed flower visitors on *Calluna vulgaris* (Common Heather) inside a frame of 80x80 cm and counted the number of visits of each bee species. In the second experiment trap nests for stem-nesting bees were exposed in April and collected in October on the different distance plots. After collecting the trap nests we counted the number of wild bee brood cells per plot.

All wild bees that were observed during flower observations were ground-nesting and visited less *Calluna* flowers when honey bees were abundant. However the reproductive success of stem-nesting wild bees was not influenced by the distance to the next honey bee hive.
Our study found no evidence for competition effects of honey bees on reproductive success of stem-nesting wild bees in the Lüneburger Heath. However, it indicates the necessity to investigate if there are competition effects of honey bees on the reproductive success of ground-nesting wild bees.

O9 – Smoke-induced germination in coastal *Calluna* heathlands - a case of management-induced evolution?

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Smoke-induced germination responses have been shown to play an important role in post-fire revegetation responses and in the population dynamics of many species characteristic of naturally fire-prone habitats world wide. Fire is also ecologically important in the coastal heathlands of north-west Europe, but here fire is a culturally induced phenomenon, dating back only a few thousand years. In this study we ask (i) if smoke-induced germination responses also operate in this culturally fire-prone system, and (ii) if such responses are unique to heathland populations of the wide-spread species *Calluna vulgaris*, suggesting that the response may be affected by local selection pressures.
We test for and quantify smoke-induced germination responses in coastal heathland seedbanks, and in *Calluna* populations sampled along parallel climate gradients in and outside the coastal heathland region of Norway (south – north and lowland – alpine, respectively).
Smoke treatment significantly increases germination in coastal heathland seedbanks. Smoke-induced germination responses were also detected in fresh *Calluna vulgaris* seeds*,* and these responses were constant along a south-to-north climate gradient within coastal heathlands in Norway (58°N- 69°N, mean annual temperature 7.3ºC – 2.7ºC). In contrast, smoke responses gradually decreased along a climatically parallel gradient from the traditionally fire-managed heathlands at the coast to alpine heathlands with no history of fire management (1 – 1020 metres above sea level, mean annual temperature 7.3ºC – -0.6ºC). This suggests that the historical fire regime may have had evolutionary consequences for germination responses of species of *Calluna* heathlands.
In a conservation perspective, this points to the importance of conserving not only a geographically diverse set of sites but also the historic management regimes of this cultural landscape to conserve the ecological and genetic diversity of coastal heathlands.

O10 – Lessons for conservation biology under global change conditions: a case study on two burnet moth species in the high altitudes of the Pyrenees

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Uphill shifts of mountainous species have been mostly associated with climate warming, but land-use change act in addition as another important global change driver. To determine the contribution of both drivers to range shifts we examined both the historical and current lower altitudinal range limits of two burnet moth species at 28 sites scattered across the Pyrenees. The arctic-alpine distributed *Zygaena exulans* showed during the last five decades an uphill shift (148 m ± SD 87 m/decade) at all sites; at four sites the species has even become extinct. For the endemic *Zygaena anthyllidis* we recorded an uphill shift at one third of the given sites (60 m ± SD 74 m/decade). While the uphill shift of *Z. exulans* can be explained by climate change, the range shifts of *Z. anthyllidis* are attributed to changes in grazing intensities. Consequently, land-use can even exceed the impact of climate change and thus is of considerable importance in conservation. We hence carried out an experiment with manipulated grazing intensities to determine favourable livestock pressure for the conservation of the endemic *Z. anthyllidis*. Egg depositing preferences (highest number of egg batches) revealed that the species favours heterogeneous vegetation structure. This habitat structure results from the temporarily lack of grazing for one season or an extensive grazing regime, thus we recommend a livestock of 0.2-0.4 livestock unit/ha for *Z. anthyllidis* habitats.

O11 – Temporal shifts in assemblages of silk moths (Saturniidae) and hawk moths (Sphingidae) in protected forests of Central Uganda

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Anthropogenic driven habitat loss and fragmentation have been happening for decades to millennia causing reduction in biodiversity. Globally, human dominated landscapes now constitute a majority of land area, with fragmented natural habitats becoming increasingly important for biodiversity conservation. In Uganda, protected forests are degraded and private ones are shrinking very rapidly, many being replaced by plantations of exotic species or agricultural crops. Between 1990 and 2000, closed canopy forest reduced from 20% to just 3% of the country’s land area. We re-sampled two moths families in three protected rainforest reserves in Central Uganda (Mabira, Zika and Mpanga), all of which are surrounded by agricultural landscapes and are situated in areas of high human population density. The re-sampling period recorded fewer moths species and lower individual abundances compared to the previous samplings in the mid-1990s and early 1970s. In Zika, the Saturnidae declined from 54 to just 20 species and Sphingidae from 46 to 34 species. In Mabira, richness declined from 40 to 30 species and 39 to 30 species for Saturnidae and Sphingidae respectively. In Mpanga, richness declined from 32 to 26 species and 46 to 29 species respectively for Saturnidae and Sphingidae.The proportions of different ecological types changed in all the forests. Widespread and forest edge species that can thrive in disturbed habitats increased both in abundance and richness, while forest dependent species showed severe decline. From extinction debt concept, creation of fragments by habitat destruction means species in the fragments are doomed to eventual extinction even if this occurs after multiple generations. Isolated fragments would lose those species that are most threatened by human activities because severity of deforestation both in terms of spatial extent and temporal scale reduces the opportunities for forest dependent species to cope with continued changes in their environment.

O12 – AgroScapeLabs (Agricultural Landscape Laboratories): Understanding animal movements in dynamic landscapes

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The survival of animals in highly dynamic environments such as agricultural landscapes strongly depends on the ability of species to cope with disturbances (e.g. ploughing, application of fertilizers) sudden changes in resource availability (e.g. mowing, harvesting) and long term changes in land use (e.g. spatio-temporal homogenization of arable crops, energy crops). Still, our understanding of animal movements in such dynamic landscapes is often limited. The trade-off between movement risks and needs is particularly problematic in landscapes where individual survival largely depends on the animals' ability to time its movements between suitable and across unsuitable habitat patches that change their configuration in both space and time. The telemetry project of AgroScapeLabs studied animal movements of hares, raccoons and red foxes in an agricultural landscape in Brandenburg. One major aim was the linkage of GPS data with specific behavioral information derived from acceleration data. This enables to determine not only the spatial position of an individual in the landscape but also certain behaviours. We first observed animals at the times of acceleration data recording and related the directly observed behaviour to the acceleration data to identify characteristic acceleration patterns. On this basis, in a final step, we applied Linear Discriminant Analysis for automated pattern recognition. In this presentation we will show first results, and will discuss current challenges and future perspectives.

O13 – European brown hare (*Lepus europaeus*) movement behaviour in an intensive agricultural landscape: a GPS tracking study

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Intensification of agriculture is known as a major threat of global biodiversity. To understand the impacts of agricultural land use on flora and fauna it is important to investigate their interaction in order to develop management strategies against the species loss. The European brown hare (*Lepus europaeus*) is one of the most characteristic species in the mid European arable landscape. Hare density has declined in many European countries and is low especially in the Northeast of Germany. The main reason for the decline may be the simplification of landscape due to intensification of agriculture.
In the frame of the AgroScapeLabs project (Agricultural landScape Laboratories) we investigated the relation of home range size of hares and landscape in the context of intense agricultural land use in the Northeast of Germany. Furthermore we investigated the impact of agricultural field use (disturbances through machinery) on hare movement distances. Disturbances were distinguished between with and without changes of resources. Ten hares were tracked using the new high accurate global positioning system (GPS).
Analysis of different landscape complexity in Northeastern Germany did not show any influence on home range sizes of hares, although the home ranges were larger compared to those of hares living in other, more complex landscapes. Disturbances with change in resources (harvesting and mowing) led to short term reactions with increasing daily movement distances, whereas mechanical field use without resource changes (ploughing, applications of plant protection products) did not affect daily movement distances. Harvested or mowed fields were used more frequently.
The increasing energy effort for increasing movement distances of the animals due to disturbance events with resource changes is likely to be compensated by new food resources on harvested fields. The low landscape complexity may lead to increasing competition for resources and therefore to low hare densities.

O14 – Impact of land use, resource dynamics and habitat fragmentation on small mammals in agricultural landscapes

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The project AgroScapeLabs (Agricultural landScape Laboratories) explores impacts of land use and quality, percentage and distribution of semi-natural habitats on mechanisms affecting biodiversity patterns and ecosystem functions at large spatial scales in agricultural habitats. As small mammals provide various functions in agricultural ecosystems (predators of weed seeds, agricultural pests, prey

for larger mammals and birds) it is important to consider their response to land use changes and landscape composition.

We studied habitat suitability and influences of land use patterns in a highly intensive agriculture in North-East Brandenburg, Germany on small mammal occurrence to develop predictive habitat selection models. We examine abundance, species richness and diversity of small mammal communities in cereal and oilseed rape fields, grasslands, field margins, kettle holes and forests, located along a gradient of landscape structural complexity before and after crop harvest.

Results showed that local habitat parameters like increasing vegetation density positively influenced small mammals especially after crop harvest. Grassland and forest habitats decreased small mammal abundance and diversity, respectively. On the landscape scale results showed that after crop harvest small mammal diversity decreased with increasing perimeter-area-ratio. The two most abundant species showed contrasting responses according to their habitat requirements. *Apodemus agrarius* abundances were highest in field margins and lowest in forests and increased with increasing vegetation density after crop harvest. While *Myodes glareolus* abundances were highest in semi-natural habitats and lowest in managed areas and strongly decreased with increasing perimeter-area-ratio.

In conclusion small mammal occurrence was mainly determined by local habitat parameters like vegetation density and habitat type, whereas landscape factors played a minor role. For conservation of small mammals in highly intensive agricultural landscapes a high vegetation density especially in semi-natural habitats can serve as refuges for small mammals according to their basic habitat requirements.

O15 – Improving performance of species distribution models for a disturbance-sensitive legless-lizard

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Species distribution models (SDMs) can be used to predict the likely occurrence of threatened species. These species often have specialised habitat requirements. Human induced disturbance to, or destruction of, key habitat resources is an important driver of decline for many of these species. However, disturbance as a measurable attribute is rarely incorporated into SDMs, which often rely on bioclimatic and topographically-based data layers.

We investigated the effect of incorporating agricultural modification data derived from remote sensing into a SDM framework by comparing MaxEnt models at two spatial scales within the Australian Capital Territory,Australia. We used the Pink-tailed Worm Lizard *Aprasia parapulchella* for this case study as it is known to have specialised habitat requirements, including a particular preference for sites dominated by species of native grass known to decline with increased levels of grazing and pasture improvement.

Soils, geology, slope, temperature, rainfall and agricultural modification were found to be important predictors and the responses of these variables confirmed habitat associations identified in previous research. We found that inclusion of the agricultural modification data into the SDMs improved model performance at both spatial scales investigated. Models without agricultural modification data predicted more areas with exotic vegetation as being suitable, whilst models with the agricultural data included predicted additional native areas. The contribution of the agricultural modification layer was higher when the model was applied at a fine scale when compared to a regional scale.

Our findings highlight the value of incorporating the contribution of one form of disturbance (agricultural modification) into a SDM framework, particularly at finer spatial scales.

P1 – Conservation challenges by transhumant sheep herding in the South Caucasus

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In the South Caucasus, sheep herding on alpine summer pastures has a long tradition. Because of its exceptional conservation value, the German Ministry of Development Co-operation (BMZ) initiated a multi-year program for "transboundary" national parks (NP) here. We conducted semi-structured interviews with local farmers, national park staff, NGO representatives, and with administrative officials (n=36) at respective sites. The Javakheti region (Georgia/GE, close to Armenia/AR) is predominantly inhabited by ethnic Armenians of GE nationality. The implementation of a recently established NP was retarded by the sale of alpine pastures earmarked for the NP to transhumant herders of Azerbeijan/AZ ethnics also of GE nationality. Attempts by the administration of Lagodekhi NP (GE, established 1912, close to AZ), to remove about two dozend alpine summer camps of herders of AZ ethnics (GE nationality) in a recent extension of the NP have been unsuccessful for several years - even with financial support from The World Bank. In both GE NPs, elements of participatory conservation planning were used. Across the border in Zaqatala NP (AZ, established 1929), the protected area was extended recently because of overgrazing of alpine pastures adjacent to the NP. Herders can be of several ethnics here. They will be denied access and referred to alternative pastures. The NP administration enforces a "fences and fines" approach. In Lake Arpi NP (Armenia, no ethnic minorities), participatory NP planning resulted in a swift implementation of the NP accepted by the local peasant population.

We conclude that participatory NP planning is complicated by (i) a tendency of national governments to locate NPs at remote border regions inhabitated by national minorities, (ii) the presence of transhumant forms of land use conducted by ethnic minorities. While current conservation planning is well able to deal with local populations and ethnically "simple" situations, the above factors pose severe challenges to the conservation of semi-natural alpine pastures. Using a strong "fences and fines" approach does not resolve the underlying land use conflicts - but it can facilitate positive conservation outcomes at least in the short run. Examples of countries with a similar approach, e.g. from Indonesia in the 1980s and 1990s, suggest that success fades rapidly, however, if the legitimacy of the governance structure is challenged, and its efficacy subsequently compromised. Long-term conservation success may require an appreciation of traditional forms of transhumant pasture use and a pro-active nationality policy by national institutions while paying careful attention to the needs of local sessile populations.

P2 – The effectiveness of protected areas for the conservation of rare and endangered vascular plant species in the Lowlands of Lower Saxony, Germany

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The establishment of protected areas is a central tool in species conservation. The 'Global Strategy for Plant Conservation' (GSPC, CBD-COP6) in this context asks for an effective *in situ* conservation of plant species to counteract the decrease of populations of endangered vascular plant species. However, on an international scale so far just a limited number of studies, coming to very different results, have examined the effectiveness of protected areas for the conservation of vascular plant species in different countries.

Using the 41 geographical regions of the Lowlands of Lower Saxony, Germany, as a model region, a method to test the effectiveness of nature protection areas and Natura 2000 sites for the conservation of rare and endangered vascular plant species (Red List species; data taken from the dataset of the Lower Saxon vascular plant assessment program, 1982-2003) is proposed. It appears that the occurrences of Red List species are unequally well covered by nature protection areas; the extension of the protected area system to include Natura 2000 sites greatly improves the situation. The approach shows that occurrence data like those gathered by the Lower Saxon vascular plant assessment program in combination with spatial data on protected areas are a good tool for monitoring the effectiveness of protected areas for the conservation of vascular plant species.

P3 – Semi-natural grasslands under climate change and human pressure in the Middle East - a modeling approach

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Fire has had potential influence on the Mediterranean landscape for hundreds of thousands of years. Although naturally occurring fires cannot entirely be excluded, it appears that man has been the principal causal agent. In modern times however, grazing by goats and sheep is the most obvious, and probably the most significant force in the destruction of vast areas. In order to assess how additional climate change in conjunction with grazing and fire will affect the vegetation cover in the Middle East in the future, we constructed the spatially explicit vegetation model WADISCAPE. This model simulates water availability in a typical wadi landscape due to elevation, exposition and daily rainfall. The vegetation responses are the responses of annuals, dwarf shrubs and two types of native trees. Their growth is controlled by water availability, competition, spatially random grazing at defined densities and fire. Climate change was simulated by using transient precipitation time series according to the

moderate (A1B) IPCC scenario. Since future climatic patterns are not expected to significantly alter wildfire patterns and regimes, fire frequency was changed systematically.
First results suggest that green biomass production and thus grazing capacity of these landscapes is quite resilient to climate change. In contrast, intensive grazing is likely to have a much larger effect on herbage productivity and therefore indirectly on erosion and runoff than climate change. Its impact on tree-growing capacity in these areas is complex but mostly with serious effects. If trees are allowed to grow in the model, there is a stimulating effect of fire on shrubs and herbaceous vegetation, but mainly in mesic Mediterranean regions and under climate change.
In this presentation, we will also discuss current challenges and future perspectives for conservation, on how modeling results can possibly be turned into some quantified tools to eventually improve decisions of decision makers in this sensible region.

P4 – Quantitative plant-herbivore networks along an agricultural land-use gradient in subtropical forests of South Africa

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Increasing agricultural land-use leads to a loss of natural and semi-natural habitats with potential consequences for biotic interactions. Besides a loss of biodiversity, the loss of natural and semi-natural habitats may also change the structure and complexity of food webs such as plant-herbivore interactions. As a result, effects on plant-herbivore networks ultimately may disturb plant growth and reproduction, and in turn forest regeneration. We therefore studied plant-herbivore interactions in subtropical forests along a land-use gradient ranging from 0 to 85 % (10 sites; radius 1000 m).
In each site we collected beating samples to establish interaction networks. Each beating sample consisted of ten standardized beats on randomly selected plant individuals smaller than 200 cm using a wooden club. Arthropods were collected in a plastic funnel (decimeter = 80 cm) connected to a collecting bottle filled with water, separated from plant material and debris and stored in plastic flasks (25 ml) filled with 70 % ethyl alcohol (for each plant individual separately). All individual arthropods have been identified to lowest taxonomic level possible (at least family level) and further grouped into morpho-species. Based on species identification arthropods were then categorized as either herbivores or predators and parasitoids, respectively.
Using indices describing quantitative networks enables us to analyze whether the structure of these plant-herbivore food webs in subtropical forests change in the face of surrounding land-use intensity.

P5 – Does the amount of trees retained at clearfelling influence biodiversity response?

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Clear-felling is one of the main methods used in many parts of the world for the production of pulp, timber and bioenergy, leading to a simplified forest structure and species composition. One of the measures to mitigate the impact of logging on biodiversity is the retention of trees at final harvest. Tree retention approaches in forestry are still rather new, although widely distributed across different continents. Several studies have been performed on the effects of retention trees on biodiversity but to date there is no evidence on the relation between the amounts of trees, i.e. the number, volume or area per hectare retained, and the response of biodiversity.
By conducting a Systematic Review according to the standards developed by the Collaboration for Environmental Evidence (CEE) we aim to provide forest practitioners and conservationists in temperate and boreal forests with more detailed recommendations regarding the amount of trees that should be retained in order to imply positive effects for biodiversity compared to traditional clear-cutting. Using specific search strings we collected over 4,000 articles from Web of Science and Scopus. Meta-analysis will be used to quantify the effects on biodiversity response, while qualitative tabulation will summarize the outcome of the review.

P6 – Restoration potential of native forests after removal of *Picea abies* plantations

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Coniferous plantations may reduce biodiversity and homogenise environmental conditions but there is a lack of knowledge on the restoration potential of such sites. We assess whether first generation plantation impact on soil and biodiversity is reversible. The study was carried out in western Norway and we compared species composition, alpha and beta diversity, and soil conditions on five sites of 4-year old wind-felled clearings and adjacent, remnant Norway spruce (*Picea abies*) plantations. We also compared successional trends between vascular plants and bryophytes. Local native birch (*Betula pubescens*) forests provided a reference point for assessing the restoration potential of the Norway spruce plantations. We found that species composition in the wind-felled clearings quickly developed similarities to species composition within the local birch forests. A rise in humus pH, calcium concentrations and available nitrogen, indicates that one rotation of Norway spruce plantations has not imposed long-term impairment of soil conditions. After removal of the plantation tree layer, mean species number per plot (alpha diversity) increased for vascular plants but remained unchanged for bryophytes. Assessment of species richness after clear-felling of spruce plantations therefore ought to include sampling of both plant groups. Heterogeneity, in terms of beta diversity, and the variance of some soil elements increased, and beta diversity trends were similar for both vascular plants and bryophytes. During the course of succession, we predict that species composition and vascular plant

alpha and beta diversity in wind-felled clearings of Norway spruce plantations may stabilise at a level similar to native birch forests.

P7 – Management of arid woodlands: effects of pollarding on *Populus euphratica* trees

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The floodplain landscape along the Tarim River at the northern edge of the Taklamakan Desert in Xinjiang, China, is naturally covered by riparian forests mainly composed of Euphrates Poplar (*Populus euphratica*). However, the area covered by forests has dramatically declined and degraded in recent times and remaining stands are heavily affected by livestock grazing and direct use of the trees such as cutting, trimming and pollarding. Within the framework of the BMBF-funded project "SuMaRiO", we investigated stands of *P. euphratica* trees located at the upper reaches of the Tarim River. The measurements included tree height, crown height and stem diameter for all trees present on the plots (50 m radius). For 20 trees per plot, increment cores were sampled and the crown area as well as the number and diameter of secondary stems were measured. Analysis of increment cores from stems and shoots allowed for age determination, identification of pollarding events and biomass allocation within trees. Individuals affected by pollarding showed a remarkable decrease in total and crown insertion height as well as in the crown projection area. In combination with lower stem increments, we estimated a lower productivity of pollarded individuals. Pollarded trees also exhibited a significantly higher degree of hollowness, with only small intact wood margins of 2 – 3 cm in many trees. The encountered high degree of hollowness might seriously affect stem stability. The sustainability of pollarding is discussed in terms of biomass production and longevity of the stands. The morphological data will further be used to assess human impact on a regional scale by remote sensing. Furthermore, we seek to identify thresholds for the intensity of use, which shall later be integrated in the SuMaRiO Decision Support System (DSS) for the local authorities and stakeholders. Keywords: growth increment, riparian forest, Taklamakan Desert, tree morphology, use intensity

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P8 – "Oh, how beautiful is Panama"? - The epiphyte perspective

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Virgin tropical forests are rich in flora and fauna and the protection of their biodiversity should receive a fair amount of attention. However, land-use changes during the last decades at a large scale ask for a shift in focus, i.e. the inclusion of human-dominated landscapes in basic research. In the tropics, previously forested areas have often been converted to a mosaic of pastures, plantations and secondary forests. Recent modelling of current human demographic trends suggests that such areas may be partly allowed to regenerate naturally into forests (see Wright & Muller-Landau 2006, Biotropica 38).

How will these forests look like? Tropical forests host many different life forms, a particularly important one being vascular epiphytes, which may account for >50% of local plant diversity, hence the current focus on trees in many conservation studies misses an important component when it comes to the conservation of biodiversity. We have begun to investigate the potential structure of the epiphyte communities in regenerating secondary forests. Seven years ago we have censused epiphytes in human modified landscapes in the Panamanian lowlands on isolated trees in cattle grazed pastures. Now, we revisited the sites, and started a suite of experiments to understand crucial processes that influence long-term dynamics in this fragmented landscape: dispersal, germination and establishment. We also compare epiphyte communities in pasture trees with those in monotypic plantations and small forest-remnants to achieve a true landscape perspective. In the talk a detailed outline of the project and findings of the first field season are presented.

Session 7 – Data – publishing, linking, using ecological data online

Chair: Karin Nadrowski

O1 – Requirements, to make biodiversity data more accessible

Birgit Gemeinholzer[1]

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Data sharing has become an important issue in modern biodiversity research to address large scale questions. Despite the steadily growing scientific demand, data is not easily accessible. This exploratory study summarises reasons for the reluctance to share data on the one hand and is evaluating the motivations for sharing on the other. Furthermore, formal and technical requirements for data sharing and reuse are being presented.

Existing data repositories related to integrative biodiversity research have been investigated in terms of infrastructures and technical solutions. The results show that database developers are mostly occupied with the implementation of state-of-the art technology and with solving operational problems. Less effort can be invested to react on user requirements and particularly to care about the implementation and testing of cutting-edge technical developments. The main reason seems to be the shaky funding situation of most repositories, resulting in a marginally small number of permanent IT-staff members.

Our results comprise recommendations to improve the current situation and aim at consolidating scattered activities to ensure sustainable data availability and use. For example, user friendly data infrastructures have to be expanded or newly designed, data management plans for all scientific investigations have to be promoted, training for the users has to be provided and motivational aspects at all stages of data submission and re-use have to be considered.

O2 – Data management in a linked world

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Ecology is not only becoming a more collaborative, interdisciplinary, and data intensive science, but data are also becoming more and more available online. Moreover, there is an increasing amount of scientists that are data (re)-users, since combining data helps in answering questions on larger time and spatial scales, as well as for a larger range of future scenarios. Cooperating research groups thus not only have to provide their data in a common online platform, they also want possibilities to link their data to other relevant platforms. Using the example of biodiversity - ecosystem functioning (BEF) data we have developed an open source generic online platform (BEFdata, https://github.com/befdata/befdata) for storage of datasets from diverse scientific disciplines and allowing for harmonizing raw data values across datasets. While raw data are not presented to the interested public and can only be downloaded with appropriate usage rights, methodological information as well as naming conventions used within the datasets are exposed on the common platform. At the same time, this information can be used by other cooperating research groups to structure their own data portals. Using the BEF data instance of the BEF-China Experiment (DFG FOR 891, http://www.bef-china.de) we give a demonstration of using the system and of setting up a new BEF data instance that can be readily used in other projects. We conclude with an outlook on useful future features of data portals in a linked world.

O3 – Biodiversity Research Data Management

Michael Owonibi[1], Birgitta König-Ries[1], Eleonora Petzold[1], Andreas Ostrowski[1]

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The Biodiversity Exploratories Information System (BExIS) (https://exploratories.bgc-jena.mpg.de) is a virtual environment for collaborative research. It was developed as the data repository and information exchange platform of the Biodiversity Exploratories project (www.biodiversity-exploratories.de). This is a long-term, interdisciplinary research platform with the goal of advancing biodiversity research in Germany. Currently, it comprises of subprojects from disciplines ranging from soil science to remote sensing and from genetics to landscape geography, resulting in a spatial resolution from a few square centimetre (genomics) to entire landscapes (airborne remote sensing), a time resolution from ½ hour of automatic climatic data loggers to 5-year return cycle of forest inventories. Additionally, BExIS is used by other projects e.g. Jena Experiment (www.the-jena-experiment.de).
BExIS offers a web-based interface to the data storage and management platform. All metadata and primary data are handled with the native XML approach using the pureXML capabilities of DB2 database. By using XML-based data storage, BExIS supports flexible data structures and the configuration (the syntax, arrangement, and data type of variables) of each dataset is defined during metadata creation. Similarly, BExIS offers support for managing geospatial (LIDAR, hyperspectral, and vector) data and other binary data e.g. pictures and documents. In addition, BExIS provides functionalities for viewing data; processing data (e.g. merging data, computing data statistics); upload, download, and update of data in different file formats (Microsoft Excel and Access, ASCII); publishing of metadata based on standards e.g. DarwinCore etc. Many of these functionalities are web services based, and can be integrated into composite service workflows. In BExIS, access to data and functionality are handled by fine grained authorization mechanisms. BExIS also provides project management tools e.g. field book and publications management tools.
Currently, BExIS is being upgraded to modular, adaptable, extendible, scalable, and generic biodiversity repository software called BExIS++. Among others, this will contain some advance functionalities e.g. GIS processing, and will support several clients e.g mobile phones.

O4 – Central database design and data synthesis in the DFG Research Unit FOR 1246 - Kilimanjaro ecosystems under global change (KiLi)

Jie Zhang[1], Katrin Böhning-Gaese[2], Markus Fischer[3,4], Andreas Hemp[3,6], Thomas Nauss[5], Marcell K. Peters[1], Ingolf Steffan-Dewenter[1]

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The DFG Research Unit FOR 1246 (KiLi) aims to assess biodiversity and ecosystem processes along altitudinal and disturbance gradients at Mt. Kilimanjaro capitalizing on its world-wide unique range of climatic and vegetation zones. It comprises seven subprojects in various disciplines which use the same 60 study sites, representing 12 major land cover types.

The KiLi central database is implemented to ensure long-term data storage, to standardize metadata, to regulate data sharing and exchange, and to prove data quality. It will allow us to perform data aggregation and integrate joint statistical analysis. It offers a web-based interface and dynamic contents related to user participation types. The KiLi central database is implemented on the basis of the Biodiversity Exploratories Information System (BExIS) thereby improving platform compatibility, data and knowledge exchange. The internal website also supports the management of project activities and documentations such as station reservation, driving plan, research permits application, event notification, literature and photo library, dynamic mailing list, and forum discussions. The KiLi central database contains three types of data storage: XML-based primary data, relational data tables, and file-based unstructured data. Metadata syntax is presented to all three data storage types using the XML approach with recycling possibility. The KiLi central database provides functionalities for uploading/downloading data in various formats (Access, Excel, ASCII etc.), viewing, query, and updating data via the web interface. It also offers an online-mapping platform for GIS data, land cover/rainfall time series maps, and a DEM for users to query spatial information through multiple layers. Access to the data and functionalities are handled by project-specific authorization mechanisms. The database will be essential for data synthesis and meta-analyses across different disciplines.

O5 – Sharing data with Metacat: the BiK-F perspective

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The Biodiversity and Climate Research Centre (BiK-F, www.bik-f.de) in Frankfurt is characterized by a large heterogeneity in research fields. It uses a broad spectrum of methods ranging from genomics and mass spectrometry to satellite-supported remote sensing of climate, area and ecosystems in terrestrial and marine environments, worldwide, with focus on the interactions of organismal biodiversity and climate.

Data heterogeneity, combined with non-uniform documentation and inaccessibility, increases the risk to lose primary as well as metadata to future researchers.

BiK-F meets this challenge by a pilot database project using Metacat, a free software package provided by the Knowledge Network for Biocomplexity (KNB). The Metacat system primarily aims at documenting data, although the data itself can be uploaded and linked to the metadata. An integrated access control feature allows to manage data and metadata with mixed access rights, e.g. granting public read access for the metadata but denying access to the data itself.
The modular database framework lets users store, query and retrieve Ecological Metadata Language (EML) documents with a SQL-compliant relational database system, e.g. PostgreSQL. A built-in replication feature allows different Metacat servers to share data (both XML documents and data files) between each other. Metacat also fully supports the DataONE Member Node interface, allowing Metacat deployments to easily participate in the DataONE federation (www.dataone.org).
As individual sites can extend and customize the system to support their data and metadata needs, the presentation will include a demonstration of how BiK-F is using the Metacat system and its components. The BiK-F Metacat system consists of a data entry form, a semantic search tool and a WebGIS client for map visualization and geographical search. Advantages and disadvantages will be discussed in relation to the BiK-F experiences and an outlook on future features will be given.

O6 – User interfaces for data transfer as part of the Diversity Workbench platform

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The modularised Diversity Workbench (= DWB) represents a virtual research environment for multiple scientific purposes with regard to management and analysis of biological data.
The platform offers a number of user interfaces for data transfer between the single components and for import and export of data.
We will describe several user-initiated processes realised to facilitate the data maintenance by data transfer between the single database components and allowing an effective import and export of object-related and taxon-related measurement and observation data from and to external data resources:

- Each component within the DWB includes functionality to search for or update entries of related datasets in linked components.
- Data can be exported as text or XML files in various formats.
- A tool for data replication of observation data exists - a precondition for the use of Tablet PCs with DWB components for ecological research.
- A specific interface for checking, validating and importing lists of taxonomic names in taxon databases exists.
- The communication between DWB components and web services providing name thesauri, nomenclators, species databases and Catalogue of Life data is realised as single object data access.
- To deliver collection and observation data for megascience platforms like GBIF and GPI/JSTOR, special user interfaces for data exports in the required XML schemas were built.
- To deliver ecological data, the DELTA and SDD data exchange formats, being TDWG standards, are supported.

- With a mobile client interface for smartphones, data from field surveys can be gathered, georeferenced and connected with photos, videos and audio comments. These data are transferred to other DWB components via web services.

Flexible data import of observation and collection data from textfiles are realised by use of a fully configurable data import wizard.

O7 – Experiences derived from the development and running of an EML-based data platform for the ecological research unit FOR816-Ecuador

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One crucial aspect within most joint projects in ecosystem research is the way of data storage and exchange. The Data Warehouse of the DFG-Research Unit 816 (FOR816dw) provides an integrative platform to enable the retrieval, transfer, storage, and analysis of scientific data of various ecological disciplines, focused on biodiversity research.

To structure the data and to make it usable by other scientists a robust metadata concept had to be implemented. The Ecological Metadata Language (EML: www.knb.ecoinformatics.org/software/eml) provides a sophisticated XML-based scheme to describe scientific ecological data sets. The relational database structure of the FOR816dw is based on the metadata logic of EML and contains at least all mandatory fields to be compliant to this specification. The metadata are transmitted by the data owner via a browser based wizard during the data upload. They can be queried for temporal, spatial, and thematically features to find data sets in the data pool. Furthermore the metadata bears information on the data set creator, the intellectual rights, and the data collection/processing workflow of each contained attribute of a data set. The adaption of the concept to describe each attribute (variable) of a data set establishes the granulated storage and analysis of the tabular data set values. All information are safely stored in the relational database and can be filtered, selected and reused.

Beside the storage and maintenance of data sets and metadata the FOR816dw provides the management of administrative tasks of the research group. The user management, the project structure, a news system, a mailing-lists generator, the travel reimbursement, and the station booking system is based on the same personnel and project specific data used for the metadata description of the scientific data sets. The project`s webpage (www.tropicalmountainforest.org) is the single point of contact for the project members and provides a user-friendly access to all information of the DFG-Research Unit 816 “Biodiversity and Sustainable Management of a Megadiverse Mountain Ecosystem in South Ecuador”.

After six years of development and running, an open source release will be available at the termination of the FOR816 in March 2013. With this in view we want to review some technical and conceptual solutions and discuss the acceptance by the users. Is the representation of EML in a relational database possible? Is the combination of project administration and data management in one platform useful? Up to what level of detail are the users willing to submit and describe their data?

O8 – TRY - database interoperability in the context of a global plant trait initiative

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The TRY initiative is a second generation of data pooling, integrating original and integrated plant trait databases like e.g. LEDA, BiolFlor, Glopnet or the KEW Seed Information Database. So far more than 130 databases have been contributed to TRY and the joint database has thus achieved an unprecedented coverage of plant trait data on global scale. In this context data standardization and data curation offer a unique perspective towards interoperability with different domain-specific databases in ecology, based on well-defined interfaces.

O9 – D³ - The Dispersal and Diaspore Database - Baseline data for seed dispersal for the Central European flora

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We introduce D^3, a new dispersal & diaspore database (www.seed-dispersal.info), which includes information on seed dispersal for more than 5000 mostly European taxa. The main aim of D^3 is to provide data that can be used to assess and quantify seed dispersal for a wide range of ecological and evolutionary questions. Additionally, the presented concept can guide the assessment of seed dispersal of further species.
Currently (May 2012), we provide 37 dispersal related items derived from empirical studies (literature database on seed dispersal), functional approaches (diaspore and plant traits, images), ecological modelling (dispersal kernels) and newly developed dispersal ranking indices (adaptation to a specific dispersal mode in comparison to other species or dispersal modes).
The included traits cover diaspore (i.e. the dispersal unit) mass, size, shape, surface structure, terminal velocity, and seed production as well as eco-morphological categorizations of the diaspore type, fruit type and the exposure of the diaspore in the infructescence, which are original and based on new concepts. Dispersal kernels for wind dispersal and dispersal by animals (epi- and endozoochory) were computed with process based seed dispersal models for standard conditions and also made available. Furthermore, we present the concept of dispersal rankings which allows an assessment how well species are adapted to dispersal modes and aims at simplifying evolutionary analyses related to seed dispersal. Finally, the database subsumes information from literature on prevailing dispersal modes and

presents digital images of diaspores, seeds, fruits, and infructescences. These items will be introduced by using an exemplary species: *Geum urbanum*. Furthermore, we will provide baseline statistics and analyses of the Central European flora that can be used for comparative studies.

O10 – Ecological online data for science and services in Southern Africa

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International, interdisciplinary biodiversity science initiatives that aim to asssess and monitor biodiversity, develop managent tools and support service provision (e.g. BIOTA Southern Africa, www.biota-africa.org or the regional Southern African Science Service Centre for Climate Change and Adaptive Land Management SASSCAL, www.sasscal.org) increasingly rely on online platforms for open access data sharing.
The talk will provide an overview of the data platforms that are currently maintained by the Module Biodiversity, Evolution and Ecology of Plants at the University of Hamburg. The freely accessible online data range from daily (real-time) weather data from automatic weather stations, site-specific soil data and checklists of lichens and vascular plants to a photo guide to plants of Southern Africa. In the course of the implementation of the Southern African Science Service Centre for Climate Change and Adaptive Land Management (SASSCAL), the data platforms and respective databases will be transferred to the SASSCAL Open Access Data Centres in the southern African region to allow immediate access to the data for scientific purposes and applied service provisions.

O11 – Red Lists 2020 – A chance to reconcile biodiversity data collection, storage and analyses in Germany

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Red Lists of animals, plants and fungi are scientific reports documenting the actual level of threat for endangered species in a certain area. The German Red Lists are published by the Federal Agency for Nature Conservation (BfN, Bonn) and updated every 10 years. A recent project residing at the Botanical Garden Botanical Museum Berlin aims to renew the Red List preparation process in order to facilitate the long-time collaboration of scientists, federal and regional authorities as well as to assist citizens and volunteers interested in nature conservation. One of the main tasks during the initial phase of the project (2011-2014) is to investigate IT-tools to simplify both the up-to-date assessment of species distribution data from all over Germany as well as the process of reviewing and valuating these data. The starting point will be online taxonomic databases based on the CDM/EDIT platform, capable to store and connect different taxonomic views, to prepare checklists sensu lato which can be used for all kinds of taxon related databases such as distributional databases, trait databases or co-occurrence databases.

O12 – The Edaphobase Project - A new generation data warehouse on soil organisms and beyond

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EDAPHOBASE (www.edaphobase.org) is a non-commercial database and information system on soil organisms (up to now including data on Chilopoda, Collembola, Diplopoda, Enchytraeidae, Gamasina, Lumbricidae, Nematoda, Oribatida) integrated in the Global Biodiversity Information Facility (GBIF) network. EDAPHOBASE combines data on taxonomy, zoogeography, and ecology of organisms in a comprehensive manner. Data originates from German museum collections, as well as publications, unpublished results of field studies (theses, reports) and collection data from German research institutions. At present, the focus is on Germany and neighbouring countries, but it is intended to incorporate data from other European countries in the future.

The most important challenge modelling biodiversity databases consists in the fuzziness of requirements when starting a project, and in the fuzziness of data as well. While objectives and basics of technical databases may be clearly defined, biological intended projects tend towards diffuse descriptions of demands in the beginning and shifts of these demands during project period. Furthermore, methods in ecology may change over years and decades. Thus, collected data parameters may be exchanged as well as working methods.

EDAPHOBASE offers a solution of the fuzziness problem while giving a wide range of tools for data input and data exploration based on a high flexible data model. A mixture of classical relational structure and an entity attribute value approach supports an unlimited number of parameters to store the data of a wide range of sources. A project overlapping data exploration is supported for any kind of ecological research. The performance of the information system may be described as satisfying, considering the flexibility as excellent.

We expect EDAPHOBASE to multiply the availability and quality of ecological data not only in soil sciences for research and varied applications in Germany and beyond.

O13 – Digital Key to the Flora of Mongolia

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With funding of the LIS program of the DFG between 2009 and 2011 a World Wide Web portal for a virtual flora of Mongolian Vascular Plants was designed, now (June 2012) comprising an updated checklist of the country (based on Gubanov 1996) with various information including taxonomy, habitat, distribution, unless valid conservation status for each taxon, and 6450 records represented either by locality data, digitalized herbarium specimens (1177), field images of the plants, including close-ups (733), or a combination of both. The idea of the project is (i) to make collections, especially those of the long series of joint German-Mongolian expeditions lasting from 1962-on-going, accessible, (ii) allow online-comparison of material for interested persons, students, and researchers working in applied projects, and (iii) creating a repository of digitalized herbarium data for taxonomists, and iv) to condense widespread information on Mongolia’s vascular plants facilitating future revisions and monographs. In

its current state, species, genera, and families of plants can be searched by taxon data, records or images.
In a second phase of the project just started, we develop the data base into an expert system, creating a computer-aided identification tool based on easily accessible plant characters. Our aim is to lead not only botanists but as well lay persons to the level of a genus or a species group, where the user can easily compare the specimen in question with the digitalized specimen information. Since printed determination books are often out of print, require special knowledge of botanical terms, with keys asking often for characters that cannot be easily observed in the field, a computer aided key would reach significantly more users. In addition, we hopefully can provide a service to upload material via the internet, to enable users to provide specimen information for revision by experts.

O14 – VEGETWEB – Open Access to Vegetation plot data from from Germany

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VegetWeb is an online archive for vegetation plot data from Germany and can be accessed through the website http://www.floraweb.de. The data model of VegetWeb allows upload, storage and interactive search of plot data with different original formats and taxonomic reference. Due to financial constraints only a small proportion of Germany's legacy of plot data has been captured so far. VegetWeb co-operates with the journal Tuexenia, for which it provides an interactive online archive of relevé tables by capturing and distributing all newly published data.
VegetWeb data are provided under the creative commons license, which allows free use for non-commercial purposes. Plot data can be filtered through an interactive online interface. Search results are presented as structured cross-tables, in which plot-ids are linked to full observation reports and plant names to the taxon sketches, distribution maps and trait descriptions under FloraWeb.
VegetWeb is a founding member of the European Vegetation Archive (EVA), which aims at making vegetation plot data more accessible to managers, policy makers and scientists.

O15 – ForestPlots.net online data management and sharing experience (2009-2012)

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ForestPlots.net was developed to provide a safe online data management and analysis tool, and to promote collaboration among researchers. Most of the data stored in ForestPlots.net was collected and/or provided by members of three international networks: Amazon Forest Inventory Network (RAINFOR), African Tropical Rainforest Observation Network (AfriTRON), and Tropical Biomes in Transition. The online application has increased the online presence of the three networks and facilitated the data collection and standardization. ForestPlots.net provides a useful resource to researchers worldwide interested in tropical ecology by making data from field campaigns from RAINFOR and AfriTRON publicly available. Researchers interested in using publicly available data have to accept and comply with the user agreement. The response of the RAINFOR and AfriTRON collaborators has been positive and more than 200 field campaigns have taken place since 2008 with the understanding that the data collected would be available to researchers worldwide. To continue promoting data sharing, data users agree to involve data providers in any research projects and publications that use their data.

O16 – From individual vegetation-plot databases, through the metadatabase GIVD to EVA, the European Vegetation Archive

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Vegetation-plot databases are a particularly valuable source for ecoinformatics as they contain co-occurrence information of plant taxa at a specific point and time, often combined with structural and environmental data measured on the plot. According to recent estimates, there are more than 2 million vegetation-plot records (relevés) from Europe extant electronically. Formats could range from spread sheets on private computers to online databases with open access. Apart from the different formats the access to these data was in the past impeded by the huge number of different databases and the lacking overview. The establishment of the global metadatabase GIVD (Global Index of Vegetation-Plot Databases; www.givd.info) in 2010 improved the situation and made the retrieval of such data much easier. GIVD presently lists 123 European databases, containing nearly 1.9 million independent vegetation-plots. The next step of data integration is now the establishment of joint European vegetation-plot database, and under the auspices of the European Vegetation Survey (EVS) Working Group of IAVS such a supra-national database has been initiated in May 2012, the European Vegetation Archive (EVA). Thirteen databases are founding members, including all big Central European ones. They have agreed to join their datasets in EVA during the course of 2012, so that by the end of this year the largest vegetation-plot database worldwide with approx. 1 million relevés shall become available. EVA has adopted Data Property and Governance Rules similar to those of the TRY (www.try-db.org) initiative for trait data and is coordinated by a Council representing the databases and a Coordinating Board for everyday business. Before EVA can go live, there is still a lot of work with unifying species lists, bibliographic reference lists, and header data structures of the contributing databases. But once these steps are done, EVA will become an indispensible tool for basic and applied ecological research in Europe that offers unprecedented possibilities.

O17 – Biodiversity Informatics Services: Fit for Use?

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Since the last decade, a rising number of biodiversity informatics projects and initiatives have aimed to complement existing human-readable user-portals with service-interfaces for machine-to-machine communication. Available services provide for example access to species occurrence and specimen data, distribution data, descriptive information, OCRed literature, as well as various computational functions.
The integration of different services in workflows using e-platforms such as Taverna (http://www.taverna.org.uk/) has great potential for speeding up data experiments and improving their reusability and reliability. In turn, the deployment and integration of services in workflows helps to identify particular shortcomings of the different service implementations which need to be addressed to increase their usability.
The EU 7th-Framework project BioVeL (http://www.biovel.eu) aims to provide a virtual e-laboratory that supports research on biodiversity issues using Taverna workflows based on a library of biodiversity services such as the Global Biodiversity Information Facility (GBIF, http://www.gbif.org), the Catalogue of Life (CoL, http://www.catalogueoflife.org/) and openModeller (http://openmodeller.sourceforge.net/). The presentation will provide insight into lessons learned in the first year of the project and contribute to the discussion of measures to reach true interoperability of biodiversity information services.

O18 – Publishing data using Digital Object Identifiers (DOI)

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Knowledge, as published through scientific literature, is the last step in a process originating from primary scientific data. These data are analysed, synthesised, interpreted, and the outcome of this process is published as a scientific article. Access to the original data as the foundation of knowledge has become an important issue throughout the world and different projects have started to find solutions.
Today libraries face more and new challenges when enabling access to information. The growing amount of information in combination with new non-textual media-types demands a constant changing of grown workflows and standard definitions.
In the last seven years the German National Library of Science and Technology (TIB) has successfully widened it range of services adapting to this new challenges:
TIB developed and promotes the use of Digital Object Identifiers (DOI) for datasets. A DOI is used to cite and link to electronic resources (text as well as research data and other types of content). The DOI System differs from other reference systems commonly used on the Internet, such as the URL, since it is permanently linked to the object itself, not just to the place in which the object is located. As a major advantage the use of the DOI system for registration permits the scientists and the publishers to use the same syntax and technical infrastructure for the referencing of datasets that are already established for the referencing of articles. The DOI system offers persistent links as stable references to scientific content and an easy way to connect the article with the underlying data.

Since 2009 the DOI registration is organised through the international consortium DataCite with 16 members from 11 countries (http://www.datacite.org). Over 1.3 million scientific objects have been registered with a DOI name so far and have therefore become citable.

P1 – Transdisciplinary research - a bridge between science and practitioners to produce reliable knowledge

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Purpose: This poster addresses transdisciplinary research between scholars and practitioners who collaboratively strive to tackle real-world sustainability problems on a regional level. It focuses on methods used to create new knowledge through involvement of different actors outside academia into the entire research process.
Design/Methodology: We conducted an exploratory analysis of 1507 peer-reviewed articles from the Scopus Database. All papers indicating at least two disciplines and one practitioner outside academia had been involved in the research project were included. Finally we evaluated 244 papers by at least two reader analysts using a standardized review-protocol.
Findings: We demonstrate that both (1) a growing number of research settings involves non-academia actors to some extent and that the term transdisciplinarity is used ever more often. However, we derive (2) that knowledge-types are not connected to specific methods and certain methods are not meaningfully employed in specific research phases. The reviewed literature suggests instead that (3) non-academic practitioners are mostly involved through different collaborative settings which often lack methodological rigor. Finally we conclude that (4) transdisciplinary research is still developing gauged on the low impact factor of current research.
Practical implications: Our review illustrates different challenges of transdisciplinary projects. It should encourage scholars to pursue involvement of non-academic actors. Further research should focus on specific methodological tools (e.g. standardized research protocol) to increase effectiveness and comparability of transdisciplinary projects.
Originality/value: To the best of our knowledge our work presents the first systematic review of transdisciplinary projects in sustainability research. We contribute to strengthening the research agenda and highlight relevant challenges in transdisciplinary projects.

P2 – Regional estimation of soil carbon stocks and changes in Germany`s forest soils based on the National Forest Soil Inventory

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The National Forest Soil Inventory (BZE) provides Germany’s greenhouse gas reporting with a quantitative assessment of carbon stocks and changes in forest soils. Soil carbon stocks of the organic layer and of the mineral topsoil (30 cm) were estimated on basis of about 1.800 soils sampled from 1987-1992 and re-sampled from 2006-2008 in a nationwide grid of 8 x 8 km. Carbon stocks and changes of the organic layer between both inventories were classified into forest stands and regionalized with CORINE land cover data. To estimate regional carbon stocks of mineral soil we designated dominant soil types and parent material for soil formation according to the Revised FAO Legend (1990). The estimated carbon stocks were attributed to dominant soil types according to the Soil Map of Germany 1:1,000,000. Subsequently, the carbon stocks for each soil type was related to Germany`s forest area with ATKIS data. The carbon stocks of the organic layer decreased from 24.7±0.4 to 24.3±0.4 Mg ha^{-1} under coniferous forests, from 16.9±0.7 to 14.8±0.9 Mg ha^{-1} undermixed forest, and from 9.5±0.5 to 7.7±0.7 Mg ha^{-1} under deciduous forest. Taking the whole forest stands into account organic carbon stocks decreased significantly about 0.04±0.03 Mg ha^{-1}. The carbon stocks of the mineral soil increased significantly from 57.4 ± 0.4 to 62.3 ± 0.5 Mg ha^{-1}, which means an annual increase of 0.32 ± 0.04 Mg ha^{-1}. In clayey soils carbon stocks were higher than in sandy soils but larger changes were detected in sandy soils, particularly in the Northern German Lowlands. We assume an accumulation of carbon in the fine fraction with enhanced clay and silt contents. The high carbon sequestration could be caused among others by (i) a higher biomass production caused by an increasing nitrogen input, (ii) a long lasting input of nitrogen and sulphur to become acidified, (iii) a changed forest management or (iv) a limited microbial activity caused by changed climatic conditions. The estimated carbon sequestration is within the scope of other studies for Central Europe. However, the used method allowed a first approach to estimate regional carbon stocks and changes. There is a wide use of modeling regional carbon stocks but in comparison to those studies the BZE analyzed a large data set. Hence, the data provided a valid sample and enabled a reliable and nationwide estimation of carbon stocks and changes for a certain period. Nevertheless, there are still uncertainties in the estimation due to sampling errors or incomplete datasets.

P3 – Using Kepler workflows in ecology

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Ecology is becoming a more collaborative, interdisciplinary, and data intensive science. While at the one hand data is generated faster than it can be analyzed, on the other hand data is lost by loosing context information that could make it reusable. Here we need effective mechanisms which leverage the integration process of heterogeneous data sets. The workflow of an analysis can be saved and graphically presented with workflow software. By saving the workflows, we can not only increase the reusability of complex data sets, but we can also reuse the analysis itself in case of big but homogenous data. In this presentation we show how the BEFdata (https://github.com/befdata/befdata) platform can be used to integrate datasets in a workflow constructed by the Kepler software (https://kepler-project.org). We use an analysis that estimates the carbon stocks of the comparative study sites of the biodiversity - ecosystem functioning (BEF)-China Experiment (DFG, FOR 891, http://www.bef-china.de). We show how the raw data columns in the original files are used within the integration and analysis process. We conclude with an outlook in how knowledge organization systems (controlled vocabularies, thesauri, ontologies) may be helpful in automating common tasks in ecological analysis.

P4 – Efficient sampling design for long-term monitoring of protected dry grasslands in Switzerland

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We present a complex sampling design for long-term monitoring of dry grasslands in Switzerland which ensures optimal statistical inference from both model and design-based statistics. The population under study is defined by the perimeter of a national inventory. The predefined target items such as bioregions and vegetation types are equally important independent of their size. Useful prior information about them is provided from the sampling frame and external data bases. Beside the conceptual constraints which are imposed from model- and design-based statistics there are practical demands that arise from field work logistics and budgets. Data recording in the field and travel time has to be well balanced and frequent nonresponse due to access problems in the field has to be avoided or compensated. To fulfill all the constraints and to optimally use the existing prior knowledge we propose a multi-stage sampling design that includes the use of modern techniques such as: balanced sampling, spreading, stratified balancing, calibration, self-weighting, unequal inclusion probability and power allocation. This sampling design meets the numerous requirements of a long-term study on rare habitats while still providing an efficient design-based estimator for finite area inference.

P5 – Vegetation Databases for the 21st Century - The Global Index of Vegetation-Plot Databases presents a Special Volume

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The Global Index of Vegetation-Plot Databases (GIVD; http://www.givd.info) is an online facility providing metadata on vegetation databases from all over the world. Based on defined criteria researchers can submit information about their databases to make the metadata visible, searchable and citable through the world-wide web. Each database gets an persistent, unique identifier and thus becomes a valuable resource for ecological and biodiversity information. Since the launch of GIVD in 2010, 182 databases have been registered with more than 2.8 million vegetation-plots, that have been mainly collected since 1970 on areas between 1 and 1000 m². In a special volume of *Biodiversity and Ecology* (which will be presented at our poster and can be bought at the GfÖ conference) the entries in GIVD are published in approx. 150 short reports, that give an abstract on the particular databases, and 21 long database reports, which contain details on the current research in the scope of the respective database. Each report is accompanied by a fact sheet that summarizes the most important aspects at one page in a print layout (e.g. scope of the database, plot types, covered countries, site-specific structural and plot-based environmental data, sampling periods, database format).
GIVD provides the opportunity to the database managers to increase the awareness of their vegetation-plot data and thus promotes the interconnection within the scientific community.

P6 – Problems with plant names in databases: EuroSL as a solution

Jürgen Dengler[1], Florian Jansen[2,3], Walter G. Berendsohn[3], Erwin Bergmeier[4], Milan Chytrý[5], Jiri Danihelka[5], Wolf-Henning Kusber[3], Flavia Landucci[7], Andreas Müller[3], Edoardo Panfili[7], Joop H.J. Schaminée[6], Roberto Venanzoni[7], Eckhard von Raab-Straube[3]

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Taxon names are used as identifiers in vegetation-plot databases and many other databases related to plant species properties (e.g. on traits, phylogeny, distribution and threat status). Such databases are being increasingly established at regional and national scale, and first initiatives for supra-national or even global databases are under way. However, joining data from different sources and different databases is a tricky issue, as taxon names are not unanimous: the same taxon often has many different names (synonyms), while the same name can refer to different taxonomic contents (homonyms s.l., including circumscriptions of the same taxon in different width). While there are meanwhile various tools that deal with the first case relatively well, the second problem is not generally acknowledged and hardly addressed in current initiatives for plant-taxon related databases. In the context of the launch of the European Vegetation Archive (EVA), therefore a team of vegetation scientists, plant taxonomists, and biodiversity informaticians met in December 2012 to define criteria for EuroSL, an electronic taxonomic reference list of all plant taxa found in the European vegetation. Apart from properly addressing the problems around synonyms and homonyms s.l., we specified that EuroSL, in order to be a functional tool, would need to combine vascular plants, bryophytes, lichens and macro-algae in the same list. Deviating from many other printed and electronic checklists, EuroSL shall comprise also non-naturalised neophytes, cultivated plants and hybrids as well as infraspecific and supraspecific taxa (such as informal aggregates). We will present our concept of EuroSL, for which we are presently seeking additional data sources, technical tools, collaborators, and financial support to put it into practice during the next years, with the aim of ultimately having it as a continuously updated online tool.

P7 – Photo Guides to Plants of Southern Africa and Southern Morocco

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African plants have evolved a diversity of forms, functions and habitats. Due to the limited number of print publications, the identification of correct species names is still a large problem, especially when large numbers of specimen need to be identified with a limited investment of manpower and time. Besides published keys and besides identification based on herbarium records, the fast screening of a sufficient number of good photographs can be a very fast approach to identification in many taxonomic groups. For this aim we developed regional online photo guides for southern Africa and southern

Morocco in the frame of the BIOTA AFRICA initiative. These guides present plant photographs in a phylogenetic order thus allowing rapid visual comparison. A number of tools allow the users to scan taxonomic groups like genera and families. Online accessibility enables non-scientific stakeholders with limited access to taxonomic literature to gain knowledge on their regional flora and to identify plant taxa. Soon, the website will also allow users to identify unknown species by entering characters like flower colour, life form, growth form into a multi-access key.

The Photo Guide to Plants of Southern African (see: http://www.southernafricanplants.net) includes a good and rapidly growing representation of all known species of the southern African region. At present, Namibia and the western parts of South Africa are best represented, while a growing number of photos from Angola, Botswana, Zambia are also included.

The Photo Guide to Plants of Southern Morocco (see: http://plantsofsouthernmorocco.biota-africa.net) aims at presenting the diversity of vascular plant species which occur in the transition zone between the High Atlas and the Sahara. The photo guide is mostly based on photos taken during field work in the Drâa catchment. Hence, this region is still best represented, but we intend to extend the covered area continuously.

Session 8 – Eco-evolutionary dynamics

Chair: Alexander Kubisch, Emanuel Fronhofer, Thomas Hovestadt

O1 – Reconstructing environmental niche evolution: is the climate niche just another species' trait?

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Understanding how a species climate niche evolved through phylogenies has gained considerable attention in comparative studies. It has the potential to shed light on patterns and causal relationships between speciation events, climate and life-history traits evolution.

The field of ancestral environmental niche reconstruction combines elements of phylogenetics, species' ecology and environmental niche modelling. But how exactly can we infer the niche of species ancestors and how confident can we be about it? The foundations for niche reconstruction methods lie in ancestral character/trait inference. A present-day niche parameter such as optimum temperature is treated as a species trait (e.g. wing length) and reconstructed through the phylogenetic tree. From these the ancestral niche is inferred at each node. There is a large variability among studies with respect to representing the continuous environmental variable. So far authors have chosen to reconstruct the mean, minimum, maximum, standard deviation and frequency histograms, or have transformed them into discrete classes using arbitrary cutpoints.

Reconstruction methods are evolving quickly and range from simple parsimony-based inference to more complex statistical approaches, which involve newly developed trait evolution models. The validity of climate niche reconstructions can be more challenging to prove than other traits; the climate of the past is rarely known and its estimates have often a considerable level of uncertainty attached; the other difficulty lies in poor availability of fossil records among ancestral species. As a consequence the vast majority of studies do not verify whether their ancestral climate niche actually could have existed at a given time, nor whether the species ancestor really occupied that region.

Based on our review we describe the current state of the art in niche reconstruction and identify gaps in this approach that need to be attended before the field can develop further.

O2 – Leaving your ancestral neighborhood makes you leave your ancestral ecosystem functioning: decomposition of oak litter

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Under global change species may need to leave their conserved, ancestral niches shared with closely related neighbors and colonize novel neighborhoods of distantly related species. Will this change the species' role for ecosystem functioning such as for decomposition processes? We studied decomposition of litter from oaks (*Quercus petraea*) growing among phylogenetically closely and distantly related neighbours, i.e. under low or high phylogenetic isolation. We used reciprocal transplantation of litter to tease apart above-ground effects (operating via litter quality) from below-ground effects (operating via decomposer biota) on decomposition of oak litter. At present the experiment lasted for 8 months. Above ground, phylogenetic isolation from neighbors led to slower weight loss but lower C/N ratio, and to higher 15-N ratios, indicating both quantitative and qualitative shifts in decomposition. Below ground, phylogenetic isolation from neighbors led to a reduced colonization by Collembola, a decrease in invertebrate diversity, and a decreased 13-C ratios, indicating qualitative shifts in decomposition. Overall, if tree individuals leave the conserved niche and neighborhood of their lineage they might also leave their ancestral role for ecosystem functioning.

O3 – Optimal plasticity and resource allocation to survival and reproduction in fragmented habitats

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Expansion and intensification of human land use represents the major cause of habitat fragmentation. Such fragmentation can have dramatic consequences on species richness and trophic interactions within food webs. Although the associated ecological consequences have been studied by several authors, the evolutionary effects on interacting species have received little research attention. Using a genetic algorithm, we quantified how habitat fragmentation and environmental variability affect the optimal reproductive strategies of parasitic wasps foraging for hosts. As observed in real animal species, the model is based on the existence of a negative trade-off between survival and reproduction resulting from competitive allocation of resources to either somatic maintenance or egg production. We also asked to what degree plasticity along this trade-off would be optimal, when plasticity is costly.

O4 – Disentangling phenotypic plasticity and evolutionary change in insects using reaction norms

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Evolutionary responses brought by environmental change can be prevented or masked by phenotypic plasticity. In addition, we often observe only changes in phenotypes and not in genotypes, which makes the distinction between phenotypic plasticity and evolutionary change challenging. For example, the common observation of earlier maturation at smaller size in exploited fish stocks can be explained both in terms of ecological interactions (release from intraspecific competition, faster growth and hence early maturation) and evolutionary change (selective advantage of early-maturing individuals). The recently developed theory of probabilistic reaction norms (PRNs) can help separate phenotypic plasticity from presumed evolutionary effects, but has been rarely applied outside the fisheries context. We briefly summarize the main methods available to estimate PRNs and discuss their applicability to insects, using lab experiments with two non-model species, the semiaquatic bug *Microvelia reticulata* and the dragonfly *Sympetrum vulgatum*, as case studies. Our focus is on the equivalence of/differences between length- and size-based PRNs, possibility to estimate PRNs for multiple life stages, and the possibility to use larval skins, which can be readily collected and routinely measured. We conclude that further development and more widespread use of PRN methods could greatly enhance the possibilities to separate phenotypic plasticity from potential evolutionary responses in the megadiverse group of Arthropoda.

O5 – Concurrent evolution of dispersal and habitat tolerance in antagonistic systems

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Antagonistic interactions like parasitism are important for many aspects of ecology and evolution. Here, we contrast the effect of commensalism and parasitism on the concurrent evolution of dispersal and habitat tolerance (specialist vs. generalist strategy). In hosts, larger tolerance is associated with a fertility trade-off; the higher its habitat tolerance is, the lower fertility an individual has. We implement a spatially explicit, individual-based 1-host-1-guest metacommunity model with landscape heterogeneity of a continuous habitat trait that affects host's fertility only. The antagonistic interaction model follows the Nicholson & Bailey equation.

Compared to commensalism, antagonism promotes the evolution of higher dispersal probability in hosts and guests. Lower emigration probabilities evolve in heterogeneous compared to homogeneous landscapes. Other than in homogeneous landscapes, parasites typically evolve higher dispersal probabilities than their hosts in heterogeneous landscapes. The effect of landscape heterogeneity on dispersal evolution depends on the magnitude of the tolerance-fertility trade-off for hosts and the search efficiency of parasites. Moreover, depending on the tolerance-fertility trade-off antagonistic interactions may promote evolution of habitat tolerance in hosts. Landscape structure affects the

evolution of dispersal and habitat tolerance in opposite ways: In clustered (autocorrelated) landscapes, dispersal probability evolves to higher, but habitat tolerance to lower levels than in random landscapes.

O6 – Effects of past and present competition on evolutionary potential and adaptation in the annual plant *Erodium cicutarium*

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Despite the large amount of information on plant adaptation to physical stressors in the environment, there is remarkably little information on the role of competition as an agent of selection. Spatial variation in the composition of plant communities likely represents a complex selective mosaic of interactions that may influence the genetic architecture of a plant species at two fundamentally different hierarchical levels. First, competition may affect phenotypic expression of genetic variation within populations and thus the evolutionary potential of the population to respond to future selective challenges. Second, local competitive regimes could represent historic selective forces that have resulted in adaptive variation among populations.
Using the annual plant *Erodium cicutarium*, a species invasive in North America and native to Europe, we investigated the following two research questions. First, how does competition influence the phenotypic expression of within-population variation in ecologically important plant traits? Second, does the past or "historic" competitive regime of a plant's source population influence its phenotypic response to experimental manipulations of competition?
Within its native range in Bavaria, Germany, we collected multiple seed families of *E. cicutarium* from 10 populations in low and high competitive environments. In the glasshouse, we planted seeds from every family in both competitive and non-competitive environments. Analyses indicate that, regardless of population seed source, there are significant effects of competitive environment on phenotypic expression of within-population variability, although not unidirectional. Plants growing under competition exhibited less among-family variation in some physiological (e.g., stomatal conductance) and morphological traits (e.g., leaf length), but more variability in other traits (e.g., leaf turnover). The competitive regime of seed source populations also influenced plant response to the competition treatments. For many traits (e.g., chlorophyll content, internode length, number of flowers, age at flowering), plants originating from populations within highly competitive environments exhibited significantly more variability than plants originating from low competition populations.

O7 – The evolutionary spatial ecology of spider mites in a stochastic environment

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Human-induced changes of the landscape often lead to the fragmentation or reduction of quality of habitat for a diverse range of organisms. Many organisms are consequently forced to live in suboptimal habitat and experience a high level of landscape heterogeneity and stochasticity. Environmental

stochasticity is generally defined as the variation in population growth caused by temporal or spatial changes of the environmental quality. As stochasticity clearly affects local population dynamics and the evolution of life history traits, it is also likely to have an impact on metapopulation functioning. The use of artificial metapopulation systems provides an ideal tool to study the effect of fragmentation and stochasticity on (meta)population dynamics. During this study artificial metapopulations of spider mites were used to test the effects of spatial as well as temporal stochasticity on metapopulation dynamics and the evolution of dispersal. We will discuss to which degree this leads to evolutionary life history changes and how this feedbacks on metapopulation performance.

O8 – The wrong place at the wrong time: range shift across fragmented habitat causes maladaptation in a modelled bird species

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Many species are locally adapted to decreased habitat quality at their range margins, and therefore show genetic differences throughout their ranges. Under contemporary climate change, range shifts may affect evolutionary processes at the expanding range margin due to founder events. Additionally, populations that are affected by such founder events will, in the course of time, become located in the range centre. Recent studies investigated evolutionary changes at the expanding range margin, but have not assessed eventual effects across the species' range. We explored the possible influence of range shift on the level of adaptation throughout the species' total range. For this we used a spatially explicit, individual-based simulation model of a woodland bird, parameterised after the middle spotted woodpecker (*Dendrocopos medius*) in fragmented habitat. We simulated its range under climate change, and incorporated genetic differences at a single locus that determined the individual's degree of adaptation to optimal temperature conditions. Generalist individuals had a large thermal tolerance but relatively low overall fitness, while climate specialists had high fitness combined with a small thermal tolerance. In equilibrium, the populations in the range centre were comprised of the specialists, while the generalists dominated the margins. In contrast, under temperature increase, the generalist numbers increased at the expanding margin and eventually also occupied the centre of the shifting range, while the specialists were located in the retracting margins. This was caused by founder events and led to overall maladaptation of the species, which resulted in a reduced metapopulation size and thus impeded the species' persistence. We therefore found no evidence for a complementary effect of local adaptation and range shifts on species' survival. Instead we showed that founder events can cause local maladaptation which can amplify throughout the species' range, and, as such, hamper the species' persistence under climate change.

P1 – Selection on plant height through the interplay of landscape and large herbivores

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In open communities, most plants are characterized by their small stature, and by seeds that apparently lack any attributes for dispersal (‘unassisted seeds’). In a seminal paper, Janzen (1984, Am. Nat. 123: 338-53) hypothesized why this might be so. Such plant communities are commonly home to large mammalian grazers (notably ungulates), which can inadvertently ingest and disperse the seeds of these plants. If this endozoochory proves successful, it might direct seeds to evolve a small size and unassisted seeds.
However, as plant architecture is subject to many selection pressures, it is unclear whether this endozoochorous selection could ever be significant to plants, and if so, under what circumstances.
We developed a computer toy model in which plant height is allowed to evolve under particular settings of the landscape and the presence of herbivores. For a set of landscapes, plants are allowed to grow, set seed, disperse (either through wind or through herbivores), and establish as new adults. According to model rules, higher plants (i) produce more seeds, (ii) have a more distant seed rain in wind dispersal, but (iii) are more likely to be destroyed by herbivores before reproduction. Four parameters are tested: two pertaining to the configuration of the landscape (habitat availability and connectedness), and two pertaining to the animal vector (grazing pressure and behaviour).
We found that the configuration of the landscape highly affected plant height, due to costs involved in wind dispersal and establishment. Plant destruction by herbivores strongly decreased plant size. Endozoochory *per se* also had a siginificant effect on plant size, but only when a considerable transfer of seeds towards suitable plant habitat was sustained.

P2 – Environmental and genetic components of trait variation in the forest grass *Brachypodium sylvaticum*

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The ability of plant species to vary their phenotype in response to changes in the environment may buffer individuals against the impacts of recent climate change. Intraspecific phenotypic variation is an indicator for phenotypic plasticity or underlying genetic diversity. Identifying the factors influencing the plastic and genetic responses may give a first insight into plant species persistence under a changing climate. In a field study in 2009, populations of the forest grass *Brachypodium sylvaticum* showed amarkedly higher phenotypic variation under warmer climatic conditions in south Germany compared to north Germany.Here, we conducted a reciprocal transplant experiment to uncouple the genetic and environmental components of trait variation in *B. sylvaticum*. We found that plants originating from the North were more variable (the coefficient of variation was used as a measure for phenotypic trait variation) than plants from the South, both when planted at their home site and when transplanted to the foreign site. Plants from the South, however, grew larger than plants from the North and produced more seeds at both common garden sites.

P3 – *Tetrahymena* microcosms – from individual cell movement to population spread

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Movement is a fundamental characteristic of life. It is involved in important behavioural responses such as foraging, mate search or predator avoidance and consequently influences important ecological processes for example the dispersal between habitats and the resulting population dynamics. In order to understand movement and its ecological consequences we need a thorough knowledge of the biomechanics of the motion process, the navigation capabilities as well as the internal and external factors which influence the movement of organisms. Understanding the rules and constraints which underlie movement will help to better predict how organisms react to environmental change and better control of invasive species and pests.
Our model system consists of different genotypes of the unicellular aquatic eukaryote *Tetrahymena thermophila*. Populations are cultured under controlled conditions in the lab allowing easy manipulation of the environment. To quantify the movement behaviour we take video shots and extract two-dimensional movement trajectories of individual cells. The movement is then summarized into metrics such as net displacement, speed and path linearity to compare genotypes and treatments of conspecific density.
First, we show substantial intraspecific variation in the movement patterns and relationships between the swimming speed and cell morphology. Second, our study links the movement behaviour expressed at the individual cell level to population level phenomena as the emigration rate. Third, changes in the individual movement due to different cell densities can partly explain the density-dependent response of the emigration rate.

P4 – Life and death in the garden: trajectories of mortality and recruitment in plants

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One group of 'classical' theories of senescence focus on the existence of trade-offs between early and late life performance. This literature, initiated by Hamilton and later supplemented by Williams, Medawar and Kirkwood, all have unitarian (non-modular) organisms in mind. These authors tend to predict that, after the age of maturity, survival will decline alongside reproductive output. Using data derived from the COMPADRE (COMparative Plant & Algae Demographic REsearch) database, we examine age-specific survival and reproduction trajectories for over 400 plant species using a matrix modeling approach. We demonstrate the existence of an astonishing variety of demographic trajectories, the majority of which do not adhere to the ‘classical’ Hamiltonian predictions of inevitable senescence. We argue that environmental filtering and phylogenetic ancestry explains much of the observed variation, and that the ‘classical’ theories of senescence are not sufficient to explain demographic trajectories in non-unitarian organisms.

P5 – Does floodplain fragmentation by dykes shape population genetic structure and clonal diversity of the river corridor plant *Cnidium dubium*?

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Nearly all large European river landscapes are strongly affected by floodplain fragmentation by dykes. However, there is a complete lack of knowledge concerning their impacts on short term evolutionary processes in plant populations.

We analyse the population genetic structure and clonal diversity in *Cnidium dubium* (Schkuhr) Thell. (Apiaceae) as a model for river corridor plant species. It occurs in grasslands of Central European river landscapes, in the recent floodplain (still inundated in periods of high water) as well as in the older floodplain (not flooded anymore). We assume that hydrochory and natural disturbances are major factors shaping plant genetic patterns in dynamic river landscapes and that fragmentations by dykes have strong effects on population dynamics in *Cnidium dubium*.

We hypothesize that stands of the recent floodplain show a higher clonal diversity due to intensive sexual reproduction and a lower genetic differentiation due to long distance dispersal than those of the older floodplain. Besides, we suggest, that due to hydrochory, in the recent floodplain genetic diversity increases more strongly from upstream to downstream populations than in the older one.

A total of 355 ramets were sampled from 22 patches of *Cnidium dubium* in the recent and older floodplain along a 400 km stretch of the Elbe River using a regular grid design. These samples were genotyped at eight quality-tested nuclear microsatellite loci. While there is a first evidence for isolation by distance effects more detailed analyses are ongoing.

The goal is to contribute to a better understanding of plant population processes in herbaceous river corridor plant species in response to river landscape alterations.

Session 9 – Ecological networks

Chairs: Björn C. Rall, Ute Jacob, Owen Petchey

O1 – The Dimensionality of Ecological Networks

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Will two individuals of different species interact if given the opportunity? If the two species have matching traits then an interaction is possible: a moth's proboscis is long enough for a flower corolla, a predatory fish's jaw can accommodate its prey. Otherwise the interactions is forbidden. Evolution continuously alters species traits to favor or prevent interactions. Rewards and deception tend to favor interactions, while chemical defenses and shells prevent them. Several traits need to match for interactions to occur: this is the fundamental idea originated with pioneering work on multidimensional ecological niches. How many traits/dimensions are needed to fully describe these niches and thus ecological networks?

Here we analyze a set of 200 ecological networks including food webs, antagonistic and mutualistic networks, and find that the number of dimensions needed to completely explain ecological interactions is small (<10), with model selection favoring the use of less than five. Using a set of high-quality networks including several species traits, we also identify which traits contribute the most to explaining network structure. We show that the inclusion of simple species traits can dramatically improve our understanding of the structure of complex networks, and provide a link between ecologically-important species attributes and large-scale community structure.

O2 – Challenges and advances in predicting parasite treatment effects in humans and wild mice

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In nature, individual hosts are often infected by multiple parasite species. Interactions among these coinfecting parasites will determine how infections respond to disturbance, including drug and vaccine use. Until recently, very little was known about the number and strength of interactions among coinfecting parasites. We used two approaches to assess the potential for interactions among coinfecting parasites: a literature based method for human parasites, and an experimental approach for the parasites of wild mice. A survey of the literature revealed over three hundred coinfecting parasites of humans exhibiting about 3000 potential interactions (i.e., connectance of 3%). Indirect interactions via host resources were more common than via the immune system. There were ten modules of closely interacting parasites, and these were mostly associated with particular part of the human body. An experimental perturbation of the within-host parasite communities of individual wild mice, in contrast, revealed relatively little evidence for interactions among parasites. Perhaps as a result, the with-host parasite communities were very stable, being both robust and resilient to treatment. We suggest that such perturbation approaches are an invaluable tool for understanding the way in which natural parasite communities are assembled, and may be critical for aiding the design of effective disease management strategies in a co-infected world.

O3 – Structure and Function of the Baltic Marine Food Web: Spatial Aspects across Environmental Gradients

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Understanding the structure of food webs provides important insights on the relationship between biodiversity and ecosystem functioning. Much of the recent food web research has focused on the characterization of detailed and complex food- webs, considering a high level of taxonomic resolution.
Here we present a highly resolved food web data set for the Baltic Sea ecosystem. Providing a difficult environment for many aquatic species, the biodiversity of the Baltic Sea is relatively low. Its fauna contains of a mixture of marine, brackish and limnic species in a complex pattern along as well as across a salinity gradient. Species richness varies between the Baltic sub-regions, depending on salinity preferences. We compiled a species list for each sub- region of the Baltic Sea, considering the distribution patterns of more than 500 species. A literature review was conducted to gain information on the diet composition and average body size for each species. Additionally, we examined species traits (e.g. feeding strategy, prey type, motility, habitat) to gain insight in the functional diversity of the ecosystem. Various statistical food web metrics (e.g. species richness, connectance, linkage density) and

other food web properties (e.g. its generality and vulnerability) were used to identify differences in food web structure between the sub-systems of the Baltic Sea.
We searched for generalities and basic patterns on how species according to their trophic function and body size are distributed within the sub-regions of the Baltic Sea ecosystem.
Our results support the recent view that species traits have a high potential to explain patterns of species distribution in food webs and that they are mandatory for the understanding of network structures.

O4 – Patterns in bipartite predator-prey webs: Analysing weighted network metrics and their ecological implications

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Interaction networks are an increasingly popular way to describe ecological communities (or, at least, parts of them). Today, the theoretical study of network patterns represented by trophic (e.g., predator-prey food-webs) or non-trophic (e.g., plant-pollinator networks) versions is largely dominated by analyses of qualitative rather than quantitative datasets. Nevertheless, a remarkable number of such datasets exist, particularly for so-called bipartite webs, i.e., webs that comprise only two functional groups such as consumer versus resource communities. One network-metric that is highlighted as a driver of stability and robustness is the compartmentalisation of networks and the „mean“ specialisation level of the species. It has been argued, however, that many studies that deal with qualititative datasets may overestimate compartmentalisation due to the uncorrected sampling bias of species that are rarely documented (e.g., „rare generalists“). To address this shortcoming, several correction methods have been suggested, among which Blüthgen's index H'_2 has been commonly applied to different types of plant-animal interaction-networks in recent years. In contrast, predator-prey interaction webs typically comprised more complex food webs with more than two levels. Since it is often intractable to get highly resolved quantitative data for complex food webs due to variable sampling and observation methods at different trophic levels, we propose to adopt the bipartite approach to subsets of predator-prey webs where highly resolved data are available. We illustrate the possibilities of our approach by analysing a comprehensive dataset of trophic fish-invetebrate interactions from Kiel bay, Germany. This approach might shed light on (1) how network properties affect stability criteria in ecological networks under human-induced stress and (2) give the opportunity to compare antagonistic with mutualistic networks on a much broader scale than previously done.

O5 – Latitudinal trends in the modularity of quantitative seed dispersal networks

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Seed dispersal by birds is a pivotal ecosystem function. However, we have surprisingly little understanding on the community-wide structure in seed dispersal networks especially across large-scale environmental gradients. One important concept yet to be tested on large spatial scales is the modularity of mutualistic networks, i.e. the compartmentalization of networks into tightly connected units. We tested whether modularity of avian seed dispersal networks changed with latitude and along gradients of contemporary climate and plant richness. We used a data set of 22 seed dispersal networks distributed across the globe (range 0 - 50° absolute latitude) and determined the modularity of each network with a recently developed algorithm for bipartite quantitative networks. We found that modularity decreased towards tropical latitudes, indicating that tropical networks were less compartmentalized and more connected than temperate networks. This latitudinal gradient in modularity was closely correlated with contemporary climate and plant richness. Our findings suggest that the latitudinal gradient in modularity could be related to an increasing resource diversity in the tropics. Another, mutually not exclusive explanation is the higher prevalence of super-generalist frugivores in tropical than in temperate systems. We propose that obligate frugivorous bird species that are restricted in their distribution to tropical latitudes play a crucial role in structuring and maintaining the functionality of tropical seed dispersal networks. Our findings of principle structural differences in mutualistic networks along latitudinal and climatic gradients underscore the importance of macroecological approaches in ecological network research and imply that the impact of land-use and climate change on functionally important plant-animal interactions may differ between tropical and temperate ecosystems.

O6 – Can forest fragmentation promote food web complexity? A case of plant-herbivore networks in (silviculturally managed) temperate forests

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Forest fragmentation is a key factor threatening biodiversity and ecosystem function worldwide due to area loss, insulation, and edge effects. While human-caused fragmentation is most severe in temperate landscapes, the bulk of research is currently directed to tropical forests with focus on single trophic levels. We studied the effects of forest fragmentation on food web structure in a hyper-fragmented forest landscape in SW Germany (North Palatinate mountainous region) by analyzing plant-herbivore interactions; this included more than 800 feeding records in 14 forest remnants across 770 km². More

precisely, we asked whether fragmentation and edge effects influence herbivore diversity, interaction complexity and network specialization. Extensive sampling in the woody understory of forest fragments, edge and interior plots (1000 m^2) yielded a rich fauna of insect herbivores, totaling 151 taxa in at least 31 families. In contrast to published studies we found that herbivore and plant diversity was highest in edge habitats compared to the forest interior. In addition, interaction networks were both more complex and specialized in edge habitats, probably as a result of higher host diversity, promoting herbivore diversity and increasing interaction complexity along with trophic specialization. Furthermore some specialist herbivores (e.g., aphids and psyllids, *Sternorrhyncha*) showed preferences for fragmentation-affected habitats, thus increasing network specialization. In contrast the forest interiors were characterized by simplified understory communities with an impoverished fauna of generalist herbivores. Apart from classical ecotone effects, these findings can be explained by a long-lasting release of edge habitats from silvicultural operations. We conclude that fragmentation-affected habitats may serve as reservoirs for species diversity and their ecosystem functions in managed forests in Europe, as opposed to undisturbed (e.g.) tropical forests.

O7 – When do evolutionary foodweb models generate complex networks?

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Understanding the conditions required for complex ecosystems to persist despite changes in the species composition and human interference, is of utmost importance in order to conserve these systems. Evolutionary foodweb models, which implement the repeated process of immigration or speciation and extinction, are very helpful at identifying factors that further complexity and stability. In such models, the foodweb structure cannot be put in by hand, but results from the combined effect of population dynamics and evolutionary dynamics. However, there is so far no agreement as to which factors are required in order to lead to the emergence of realistic foodweb structures. Some models require adaptive foraging behaviour and metabolic scaling effects in order to show species richness and complexity. In contrast, other models achieve this goal by including an intraspecific competition term. In our work, we compare these different approaches with respect to their various stabilising or destabilising effects. We present computer simulations of different model modifications and discuss the conditions required to yield complex networks.

O8 – Effects of introducing a competing salmon species into a model of sockeye salmon population dynamics

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The number of spawning sockeye salmon in the Fraser River basin in Canada shows a remarkably strong and regular four-year oscillation. This so-called cyclic dominance phenomenon is reproduced as a stable

attractor by a recently introduced three species model for salmon fry, their zooplankton food, and their main predator in the rearing lakes, rainbow trout.
However, this simple model does not take into account that all sockeye rearing lakes also contain kokanee salmon, which belong to the same species as sockeye. Unlike sockeye, which migrate to the ocean at age one, kokanee spend their entire life in the lakes.
We investigate the dynamics of models that include kokanee salmon in addition to the other three species. This increases the predator biomass by providing a stable food source. In the simplest version of the four-species model, cyclic dominance breaks down over a large parameter range, because it reduces the required strong coupling between sockeye and their predators. Because cyclic dominance is observed in nature nevertheless, we also study other versions of the four-species model. In particular, we investigate whether splitting kokanee and/or rainbow trout into different age classes can increase the parameter range over which cyclic dominance is observed.

O9 – Body mass, dispersal and feeding constraints drive food web assembly

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Food webs are often described as static networks of interacting species that come from a predefined species pool. At the same time, studies of community assembly have mostly avoided complexities of food web interactions and assumed random, species-invariant dispersal rates and discrete trophic levels. Hence, little attention has been paid to the process of food web assembly and subsequent temporal dynamics when species enter the food web asynchronously. To bridge this gap, we build a modelling framework to study food web assembly that incorporates realistic food web structure and dispersal rates that depend on body mass. We find that colonization success, food web structure (connectance and proportion of basal species) and body mass distribution vary systematically during the assembly process and among different dispersal scenarios. Most importantly, food webs assemble at a slower pace when small species disperse better than large ones and even more so when this relationship is reversed. Our results demonstrate that the scaling of dispersal rate with body mass fundamentally affects food web assembly with potential implications for community stability during early stages of food web development in newly colonized environments, such as islands or restored habitats. We suggest that a synthesis of the research on dispersal and extinction-colonization processes with classical food web models could provide a paradigm shift in the theory of community assembly.

O10 – The effect of migration between patches on the stability of foodwebs

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During recent years, several factors that stabilize food webs have been identified. Among these are allometric scaling of metabolism with body size and adaptive foraging. So far, food web models rarely take space into account. However, it is known that being distributed over several spatial can have positive as well as negative effects on the stability of metacommunities.

Using computer simulations for the population dynamics of systems with many species, we investigate the stability of food webs that are distributed over several patches that are connected by migration. We evaluate species persistence in dependence of foodweb complexity, patch arrangement, and migration rule. In particular, we study conditions under which migration alone, without the above-mentioned additional stabilizing factors, can increase food-web stability. We also determine whether food webs that already have a high stability can gain further by being distributed over several patches.

O11 – The importance of light fluctuation on a marine phytoplankton community

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In the last decades the diversity-stability relationship was a highly debated issue in ecology. Therefore, several studies addressed the effects of spatial dynamics on community stability by calculating the resistance and resilience under different disturbance regimes. However, only a handful studies investigated the importance of fluctuating environments on community stability, but none of these studies have been addressed in a metacommunity context.

In this study we used the metacommunity framework to address the impact of temporal fluctuations on structural and functional stability by using marine phytoplankton as model organism. One metacommunity set consisted of three microcosms (patches), which were connected by silicone tubes allowing different dispersal rates. The experiment was 3 x 3 factorial design manipulating dispersal and fluctuation. The three dispersal rates were low, intermediate and high (10min*2 day^{-1}, 30min and 120min *day^{-1}) and the light levels were (100, 60 and 20 $\mu E*m^{-2}*s^{-1}$). For the control group, all patches were maintained at the intermediate light level, while for both, asynchronous and synchronous treatment, light levels altered in a weekly interval. For the synchronous treatment the light levels switched synchronously for all three patches in each metacommunity, whereas for the asynchronous treatment light levels switched asynchronously for each patch within the metacommunity set. The experiment was run for six weeks with a weekly sampling interval, to analyse the species composition and to calculate species richness, community evenness and algal biomass at the local patch and metacommunity scale.

First results showed, that species richness decreases more at both, regional and local scale in the synchronous treatment, whereas the asynchronous treatment showed a more slightly decline over the experiment duration. By contrast, the evenness was only slightly affected by the different treatments. Both, temporal and spatial dynamics are important to maintain species coexistence and prevent species from extinction by suppressing the growth rate of the superior competitor.

O12 – Illuminating the dark: Effects of climate change on soil communities

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Soil ecosystems are the foundation of our living as they maintain a number of important ecosystem processes. Thus, soil enables plant life and food production and should be taken into account when investigating effects of climate change. Especially on agricultural systems, climate change may have a high impact because of low vegetation cover leading to even higher temperatures and drought. Nevertheless, effects of climate change on the soil ecosystem and the organisms therein are mostly still unexplored.

Here, we investigate how soil communities are affected by temperature and drought: we took a simplified but complex soil community spanning several trophic levels into the laboratory in the most natural system possible, using soil cores with their natural pore structure and a natural microfaunal community. Maize litter was introduced on top of the soil which was decomposed by the fungi present, thus providing both a microhabitat and food to fungi-feeding collembolans. As top predators preying on the collembolans we introduced mites and geophilids. To address the impact of climate change on the species' interactions, the experiment was run over temperature- and soil humidity gradients.

On most interactions, temperature had a higher impact than drought. As some interactions were negatively affected and some positively, it is difficult to make general predictions on the impact of climate change on food webs. However, the results show that temperature and drought may interact, thus future experiments should take both temperature and humidity into account. Climate change strongly influences soil ecosystems and thus is of high importance for the ecosystem functions we depend on. Therefore, when investigating the impact of climate change we should never forget the small and invisible species living belowground.

O13 – How is community stability affected by altered bottom-up and top-down effects?

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Environmental changes are expected to alter trophic interactions and thus the interaction topology of ecological communities. This is particularly the case for the relative strengths of bottom-up and top-down effects of multitrophic communities. Community stability, in turn, strongly depends on particular aspects of interactions like direction and weight. However, it is not yet quantified how much community stability is affected by altered trophic interactions due to environmental changes. We used functional group based tritrophic networks of four whole grassland communities to examine how environmental changes may alter community stability because of changes in bottom-up and top-down effects. For stability measuring we adopted a recently developed methodology that highly improves realism of analysis of functional group based ecological networks. We analyzed both a systematically altered relation of bottom-up and top-down effects and several literature based scenarios of changes in bottom-up and top-down effects. Also, we applied different scenarios of functional group vulnerability to environmental changes. Our results illustrate the effects of altered bottom-up and top-down effects on community stability. We highlight the importance of correlated effects of altered trophic interactions and particular highly vulnerable functional groups. We suggest that the net effect of environmental changes on the stability of ecological communities will dependent on the relative strengths of bottom-up and top-down processes or rather their gradual changes.

O14 – Warming alters food web structure and complexity

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The Earth is currently undergoing a level of atmospheric warming unprecedented in historical times. Research to date on the biological impacts of climate change has largely focused on the phenology and physiology of individuals, as well as changes in species range shifts and distributions. However, impacts of environmental stress on higher levels of organisation such as communities and ecosystems cannot be predicted from effects on individual organisms alone. As such, it is imperative that we consider the consequences of future climate change scenarios on the structure and complexity of whole systems. Most studies investigating climate change impacts at the community level are limited by the use of tightly-controlled laboratory conditions or tend to be temporally or spatially confounded. Here, we overcome these limitations by using a geothermal stream system to show that warming simplifies ecological network structure and alters the flow of energy through food webs. These effects will have profound consequences for stability, resilience to extinction and the continued delivery of ecosystem services. Given the universal projections of rapid warming over the coming century, these results provide an early warning signal of impending ecological change.

O15 – Allometric food web models

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Body size is a key trait that determines to a large extent the trophic positions of species in a community. Empirically it is well established that predators are mostly larger than their prey. Theoretical results show that even when starting from randomly connected networks that lack this size structure, food webs with a clear body-size structure emerge dynamically by adaptation of predators to prey species with smaller body sizes, as this is dynamically and energetically more favourable. Here we propose a model for food web topology that uses information on the body sizes of the species directly to predict the network structure of the food web. Unlike other models of food web structure this approach does not aim at reproducing statistical properties of empirical networks, but uses mechanistic assumptions on how body size constrains feeding interactions and thus determines trophic links. We demonstrate that such a mechanistic approach to food-web structure provides a powerful theoretical tool for the analysis of dynamic trophic networks. For example, it allows for a direct, trait-based definition of functional diversity and we further show how it can be generalised in a natural way to account for more advanced scenarios like ontogenetic diet shifts in species with a complex life cycle. Finally, comparison of model food webs with empirical food webs is facilitated with this approach, as it requires only

information on characteristics of the network nodes and not on quantities that describe the network as a whole, like connectance.

P1 – Logging reduces redundancy and robustness of temperate plant-frugivore networks in the forest interior but not at edges

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About 73% of Europe's forests are shaped by forestry. Yet, it is unclear to which extent forestry activities such as logging and human-shaped forest edges alter the structure and specialisation of plant-frugivore networks and consequently seed dispersal. In Europe's last primeval lowland forest in Białowieża (Eastern Poland), we recorded fruit removal from fleshy-fruited plant species (1546 interactions in 774 observation hours) at ten study sites located in the interior and at edges of logged (stand age: 20–50 years) and old-growth forests (100–150 years). Plants at forest edges received more frugivore visits than those in the forest interior. Logging had no effect on frugivore visitation rates. Furthermore, logging caused a substantial increase in network specialisation in the forest interior but not at edges. This pattern was less pronounced for functional redundancy (effective number of frugivore species per plant weighted by interaction strength) as a subset of frugivores dominated interactions at forest edges. However, these species showed a high level of generalisation in fruit choice and contributed to low network specialisation at edges. We conclude that due to low specialisation and high interaction frequencies, seed dispersal processes at forest edges are robust to loss of specialised frugivores—despite the dominance of a subset of frugivores. Conversely, the low level of functional redundancy in the interior of logged forests implies a high potential for disruption of frugivore-mediated seed dispersal. Therefore, our study highlights the value of old-growth forests for the conservation of frugivore-mediated seed dispersal processes.

P2 – Interactions between green algae and invertebrate primary consumers under abiotic stress as an important keystone in basic and applied research

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Food production is one of the important tasks nowadays and in the future. However, it has many negative side effects on the environment: desertification, eutrophication due to fertilizers and pollution from waste and by-products. To deal with those threats and to increase the knowledge about the underlying ecological mechanisms is an important task. Humans have an impact on many parts of the environment. However, without understanding of the underlying mechanisms, nobody can estimate the results of such impacts.
Our working group tries to link basic and applied research questions.

We decided to investigate how the food quality influences the survival of soil and aquatic organisms under different stressful conditions that are clearly influenced from human life.
In our first research topic, the influence of algae as a food source for collembolans on the survival and diversity of the microfauna in a sandy soil was investigated. This is especially important where desertification threatens the environment. The second research question addresses the influence of fertilizers and especially the content of phosphorus in the soil on the soil fauna. The third research question investigates in a small aquatic food chain, whether the amount and quality of food influences the toxicity of silver nanoparticles that are commonly used in textiles or food packages.

P3 – Multiple morphological determinants of size-selective predation in predatory freshwater insects

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Body size is a key trait affecting food web link strengths, and predator-prey body-size ratios play an important role in food web structure and functioning of entire ecosystems. We carried out laboratory experiments with ~25 species (~50 stages) of predatory aquatic insects that were each offered a range of differently sized individuals of the waterlouse, *Asellus aquaticus*, to assess their size selectivity. We found that nearly all predators fed selectively and, on average, larger predators fed on larger prey. Water bugs (Heteroptera) preyed on larger *Asellus* than odonate larvae of the same size; results for larval and adult diving beetles (Coleoptera: Dytiscidae) were intermediate. Statistical models incorporating multiple morphometric traits of the predators provided better description of the observed mean prey size than models based only on predator length, head width, or size of the feeding apparatus. Our results thus suggest that descriptions of predator-prey interactions need to consider multiple traits.

P4 – Predation rates on calcareous grasslands depend on adjacent habitats

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Predator spillover, the movement of predators across habitat borders, can provide important ecosystem services like biological pest control. We assume that predators frequently move between calcareous grasslands and adjacent crop fields and forests. We examined the spillover by measuring the predation rate of ground-dwelling predators by exposing lady-bird eggs as prey items on calcareous grasslands. We found a significant higher predation rate when coniferous forest was the adjacent habitat compared to crop fields. We found no difference in predation rate before and after crop harvest. We conclude that spillover of predators into calcareous grasslands depend on the type of adjacent habitat. Thereby coniferous forest is a better source of predators than crop fields.

Session 10 – Ecological stoichiometry: Alterations through environmental change and impacts on organisms and ecosystems

Chairs: Vanessa Minden, Harry olde Venterink, Stefanie Nolte, Mark Gessner

O1 – Stoichiometric constraints of biodiversity-function relationships

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The changes in ecosystem processes with altered biodiversity are a major focus of ecological research. Despite numerous examples for such relationships, we lack a general framework linking the mechanisms constraining biodiversity and the mechanisms mediating biodiversity effects on ecosystem functions. Here I propose that ecological stoichiometry may be a suitable framework, basing coexistence and function on the relative availability of and demand for multiple nutrients. Summarizing aquatic and terrestrial research, there is indication that ratios of available nutrients predict both, biodiversity and productivity, as well as the transfer or available resources into biomass production. Consequently, biodiversity also affects the chemical composition of plant biomass and the transfer of biodiversity effects along trophic interactions.

O2 – The role of diversity in stoichiometric interactions in aquatic food webs

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Food web dynamics that go beyond simple consumer-prey interactions include the effect of material imbalances of the potentially growth limiting nutrients. Being a subject of major interest in the field of ecological stoichiometry, the importance of these nutrient imbalances for trophic interactions has recently gained increasing attention. Nevertheless, it remains unclear whether consumer or producer diversity influences the effects of material imbalances in trophic interactions. We conducted three laboratory experiments to test the hypothesis that the number of species in a trophic group alters the nutrient dynamics in a pelagic community. We investigated the effect of producer and consumer diversity under different light and nitrogen supply ratios on the stoichiometric interaction between different phyto- and zooplankton species. In corroboration with the light-nutrient hypothesis and predictions of ecological stoichiometry phytoplankton biovolume and C:N ratios were significantly affected by differences in light and nutrient supply. These changes in food quality influenced grazer performance. Grazing rates i.e. were higher with -N high light food, indicating compensation for poor food quality. Producer diversity significantly increased algal biomass while algal C:N ratios decreased in polycultures under light limitation. Consumer biomass increased when feeding on mixed algae cultures. Consumer diversity had significant effects on algal and herbivore C:N ratios and altered consumer and producer biomass. Our results indicate that stoichiometric constraints of trophic interactions are altered by producer and consumer diversity.

O3 – Match and mismatch between litter and stream detritivore stoichiometry: Consequences on decomposition and growth

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Leaf litter of terrestrial origin is a key component of nutrient and energy budgets in forested streams, and a primary food source for litter-consuming invertebrates. Nutrient concentrations of leaf litter tend to be low and also vary considerably among plant species, whereas detritivores have higher nutrient concentrations and tend to regulate their elemental body composition more tightly. As a result, strong imbalances can arise between the nutrient ratios of leaf litter and the needs of litter consumers, although substantial differences exist among detritivore species. This could trigger compensatory feeding or constrain growth, depending on the consumer nutrient requirements. Accordingly, we hypothesized that different aspects of detritivore performance, defined in terms of leaf consumption vs growth, respond differently to variation in resource and consumer stoichiometry. To test this hypothesis, we exposed three litter-consuming invertebrate species that differed in their body N:P ratios to four types of litter with varying N:P ratios and measured both litter mass loss and consumer growth. Both refractory and more labile litter species were included. We found that low N:P ratios of litter constrained growth of detritivores with high N:P ratios of their body tissue. Contrary to our hypothesis, we did not observe compensatory feeding when litter and detritivore N:P ratios showed a mismatch. However, when offered diets of mixed litter with varying N:P ratios, detritivores preferred the litter species showing the closest match to their own N:P ratio. In particular, detritivores with high body N:P ratios enhanced decomposition of high N:P litter and slowed decomposition of the paired species. These results highlight the role of stoichiometric controls on detritivore growth and litter decomposition, and demonstrate how changes in litter N:P quality can affect aquatic food webs and overall ecosystem functioning.

O4 – Climate change effects on macrofaunal litter decomposition: the interplay of temperature, body masses and stoichiometry

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Macrofauna invertebrates of forest soil systems provide important services by decomposing soil organic mater, which is affected by the nutrient stoichiometry of the leaf litter. Climate change effects on forest ecosystems include warming and decreasing litter quality (e.g., higher C/N and C/P ratios) induced by higher atmospheric CO_2 concentrations. While litter-bag experiments unravelled their separate effects, a mechanistic understanding how interactions between temperature and litter stoichiometry driving decomposition rates is lacking. In a laboratory experiment, we filled this void by quantifying decomposer

consumption rates analogous to predator-prey functional responses that include the mechanistic parameters handling time and attack rate. Systematically, we varied the body masses of the isopod decomposers, the environmental temperature and the resource between poor (hornbeam) and good quality (ash). We found that attack rates increased and handling times decreased (i) with body masses and (ii) temperature. Interestingly, these relationships interacted with litter quality: small isopods avoided the poorer resource, whereas large isopods exhibited increased, compensatory feeding of the poorer resource, which may be explained by their higher metabolic demands. The combination of metabolic theory and ecological stoichiometry provided critically important mechanistic insights into how climate change effects such as warming and varying litter quality may modify macrofaunal decomposition rates as a vital function of forest soil ecosystems.

O5 – Effects of nitrogen deposition and reduced summer precipitation on floodplain meadows along a climatic gradient at the Middle Elbe River

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Floodplain meadows belong to the most diverse plant communities in Northern Germany. These ecosystems are characterized by high water level fluctuations with flooded conditions in winter and spring and dry periods during summer. Climate change scenarios indicate an increasing risk for summer droughts in Northern Germany due to less summer precipitation (10% – 30% less summer precipitation while the annual amount remains the same).
From 2009 to 2011 we conducted a field experiment in two *Cnidium dubium*-floodplain meadows to investigate the effects of reduced summer precipitation in combination with increased nitrogen availability. We reduced summer precipitation by app. 25 % with rainout shelters and simulated nitrogen deposition by fertilization (equal to 35 kg N ha^{-1} a^{-1}). The two experimental sites were situated along a climatic gradient to determine if plants living under more continental conditions today are already pre-adapted to summer drought or are even more sensitive for further reduction of summer precipitation than plants living under more oceanic conditions.
As response variables we measured species composition, species richness, biomass production, and the forage quality of biomass. Further, the plant biomass was separated in the biomass of *Cnidium dubium* and that of all other species. The resulting samples were analyzed regarding contents of nitrogen (N), carbon (C), phosphorus (P), and potassium (K). Preliminary results indicate that biomass production of *Cnidium dubium* is affected by the experimental treatments while total biomass of the vegetation remains unchanged. Continuative results will be presented and discussed.
This experiment took place in the framework of the project KLIMZUG-NORD which aims to develop adaptation strategies to climate change in the metropolitan region of Hamburg. The goal of the subproject presented here is to develop management strategies for a sustainable use of species rich floodplain meadows under changing climatic conditions.

O6 – Species loss, invasion and diversity of plant communities; a N:P stoichiometry perspective

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Nutrient availability is considered as an important controlling factor for species diversity in plant communities, and nutrient enrichment is seen as a major cause for species loss and alien plant invasions. Whereas in many studies, nutrient', ‚nitrogen (N)' and ‚phosphorus (P)' are used as synonyms, we specifically studied aspects of species loss, invasion and diversity from a perspective of the relative availabilites of N and P.
We present four theoretical mechanisms by which species richness might be different under N or P limitation, and data from Eurasian wetlands to support one of them. We show that species that are actually getting lost – Red List species – persist better under P limitation than under N limitation, both in Eurasian wetlands and in the Brazilian Cerrado. Based on an analysis of plant traits we conclude this is more likely a result of P enrichment than of N enrichment in the wetlands. For the Brazilian Cerrado we found that also alien plant invasions are related to N:P stoichiometry. The alien plants, particularly some African grasses, dominate under N limitation. Moreover, in fertilization experiments they respond to P fertilization, not to N fertilization. Under unfertilized conditions they profit more than native species from increased phosphatase activity induced by species interactions.
All our results show that plant species and communities respond very differently to N or P enrichment. Since also different management measures are required to counterbalance such enrichments, it is crucial to evaluate how such measures might influence N:P stoichiometry. Ignoring discrepancies between demanded and predicted effects on the type of nutrient limitation likely will frustrate the achievement of conservation targets.

O7 – Geographic gradients in nutrient tracking by ant communities on Mt. Kilimanjaro, Tanzania

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Despite the chemical diversity of living organisms and spatial patterns of biogeochemistry, there have been few studies of the geography of nutrient limitation in consumer communities. We analyzed how the tracking of tropical ant communities for nutrients varies along gradients of elevation (~temperature), precipitation, and land use. We made use of the steep climatic gradients and the availability of natural and disturbed ecosystems at Mt. Kilimanjaro (Tanzania, East Africa) to investigate ant activity and demands of communities for multiple nutrients (water, salt, protein, sugar, and oil) in different environments. Standardized bait experiments were performed on a total of 40 study sites between 860 m and 3880 m asl in natural and disturbed habitats. Ant activity showed a linear decline with increasing elevation in natural habitats but a humped-shaped distribution in disturbed habitats. We show that nutrient preferences of ant communities strongly vary along gradients of elevation, precipitation, and/or land use for nearly all considered nutrients. Our data suggests that nutrient limitation of animal communities shows a strong geographic signal, which is probably caused by variation in both the environmental availability of nutrients and the functional composition of species communities.

O8 – Nurturing metagenomics: nitrogen flows from ecosystems to genes point to the material costs of evolutionary change

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The elucidation of the genetic basis of ecosystem processes is one of the open challenges in the metagenomics era. Recent advances have shown a direct impact of resource constraints from the environment on the evolution of genes and proteins of species, suggesting that the material costs of evolutionary change play a pivotal role in constraining the evolution of species in response to nutrient limitations in natural ecosystems (reviewed in [1]). For example, the nitrogen content of molecular sequences has been established as a marker to trace connections between the genome and the eco-physiology of the organisms [2-5]. However, these results have primarily relied on few well established genetic model organisms, leaving the question of the relevance of adaptation to nutrient availability in natural environments only partially addressed.

Recent advances in metagenomics allow to extend our understanding of the impact of the evolutionary history of nutrient limitation on molecular evolution in a biogeochemical framework, providing a major arena to directly quantify the allocation of nutrients from the abiotic habitat to genes and proteins in environmental samples. Following the biogeochemical cycling of nitrogen in different types of ecosystems, here we evaluate the evolutionary consequences of environmental availability of nitrogen on the material costs of genetic change across trophic levels using the power of genomics and metagenomics. The results reinforce the pivotal role of nitrogen-limitation in shaping proteome and transcriptome composition within and between species in natural communities.

- [1] Elser JJ, Acquisti C, Kumar S 2010 TREE 26, 38-44
- [2]Baudouin-Cornu P et al. 2001 Science 293, 297-300
- [3] Bragg JG, Hyder HC 2004 Proc. Roy. Soc. London B 271, 374-377
- [4]Acquisti C, Elser JJ, Kumar S 2009 Mol. Biol. Evol. 26, 953-956
- [5] Acquisti C, Kumar S, Elser JJ. 2009 Proc. R. Soc. London B 276, 2605-2610

P1 – Footprint of nitrogen limitation in the transcriptional response to nutrient stress in *Saccharomyces cerevisiae*

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Merging the perspective of biological stoichiometry and molecular evolution, recent evidence has revealed that the atomic composition of proteins and genes have adaptive significance. It was shown that this phenomenon plays a key role in many diverse fundamental molecular processes such as gene duplication, and evolution of cellular components and metabolic functions (reviewed in [1]). Organisms constantly perceive and integrate information from their habitats, and have evolved mechanisms to respond to limiting availability of key nutrients with specific transcriptional responses. In this context, the possibility exists that over macro-evolutionary time scales the composition of proteins over-expressed in response to nitrogen starvation has been shaped by selection, favoring amino acid usage biases that conserve nitrogen.
To test this hypothesis, we use S. cerevisiae as a model organism to assess the role of nutrient stress on the evolution of the transcriptional response. With a genome-wide approach, we quantify the level of nitrogen allocation in proteins highly expressed in response to nitrogen starvation (data from [2-3]). Comparing over 5000 proteins, our results show a significant decrease of over 5% in nitrogen content of proteins highly expressed under nitrogen starvation compared to the rest of the proteome. Furthermore, comparing transcriptional profiles under different type of nutrient stress (e.g., nitrogen, glucose, sulfur, and phosphorus starvation), we show that eco-physiological selection for nitrogen conservation specifically targets proteins highly expressed in response to nitrogen limitation.
These findings suggest that the evolutionary history of nitrogen availability has directly constrained the molecular architecture of the biotic processes that enable cells to respond to this ecologically relevant environmental cue.

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- 2.Mol Syst Biol, 2006, 1038/msb4100069
- 3.Plos Comp. Biol.,2009, 5(1): e1000270

P2 – Evolutionary StoichioGenomics of plankton: from ocean-water to protein composition along a gradient of nitrogen availability

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Oceans are the largest habitats on earth, covering two-thirds of our planets' surface. Despite the increasing effort, our understanding of the genetic basis of adaptation to nutrient limitation in ocean waters is still limited. In an ecological stoichiometry framework, evolutionary change in oceans might be constrained by material costs, with the composition of the genetic material of marine organisms reflecting the availability of limiting nutrients (e.g., nitrogen) in the environment.

The availability of nutrients varies substantially across latitude and longitude on surface waters (e.g., coastal waters being richer in nutrients than open ocean waters). Thus, marine environments provide an ideal set of related ecosystems to study the effect of environmental nutrient limitation on the evolution of protein and transcript composition in natural communities. Recent advances in metagenomics, allow inferring a picture of the microbial community composition and biological activity at the molecular level. Combining over 30 metagenomic datasets from the Global Ocean Survey (https://portal.camera.calit2.net), with geographical distribution of nitrate concentrations from the World Ocean Atlas 2009 (http://www.nodc.noaa.gov/OC5/WOA09/pr_woa09.html), we are able to estimate the availability of nitrogen across the different metagenomics sampling sites. In this context, the analysis of the evolutionary dynamics of highly expressed proteins in the diverse microbial communities in different locations, enables us to directly link the environmental availability of nitrogen to different adaptive strategies of genome evolution. The results reinforce the relevance of environmental nutrient availability in shaping evolutionary change.

P3 – Soil metagenomics to unravel the signature of fertilizers on the molecular composition of the bacterial ribosome

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Soil represents probably one of the most complex and diverse ecosystems on our planet. Influenced by many geochemical, physical and biolological parameters, soil is a challenging environment, with a microbial diversity exceeding that of any other ecosystem [1]. Besides natural fluxes in the environmental composition of soils, humans artificially introduce changes in the availability of key nutrients by fertilization of agriculturally used fields. While the fertilizers are used to supply nutrients that are essential for the efficient growth of crop, the high abundance of biologically usable nitrogen in the soil also affects the diversity and molecular composition of microbial communities.
Extending the biological stoichiometry approach to molecular evolution, with comparative genomics of plant model organisms in a past study we have indicated that the use of nitrogen-rich fertilizers has likely left an imprint in the nitrogen allocation in proteins of crops compared to undomesticated plants [2]. Here, using metagenomic data from different agricultural and natural soils, we show with a molecular evolution approach that in the microbial ribosome nitrogen allocation is higher in agricultural than in natural soils, mirroring the environmental availability of nitrogen. These findings further point to the role of nutrient availability in shaping evolutionary change, and expand on the relevance of agricultural fertilization in impacting the evolutionary dynamics of the microbial communities in the soil.

- [1] V. Torsvik, L. Øvreås 2002 *Curr. Opin. Microbiol.* 5:240-245
- [2] C. Acquisti, J.J. Elser, S. Kumar 2009 *Mol. Biol. Evol.* 26, 953-956

P4 – Hot spring metagenome reveals the impact of environmental nitrogen limitation on the elemental composition of proteins

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Bison Pool, a flowing alkaline hot spring in the Lower Geyser Basin of Yellowstone National Park, represents an ideal ecosystem to investigate the role of nitrogen availability in shaping evolutionary change in natural communities of microorganisms, owing to the availability of metagenomic and biogeochemical data along a temperature and nitrogen availability gradient [1]. The combination of very low nitrogen availability in the source waters (both in mineral and organic forms) and the high temperature (above 92 °C) hindering nitrogen fixation, makes the hotter parts of the pool a severely nitrogen limited environment for the microbial communities. As the temperature decreases along the flow of the water, nitrogen fixation becomes possible (at temperatures below 73 °C), reducing the severity of nitrogen limitation in the colder spots [2].
Analyzing metagenomic samples along the temperature and nitrogen availability gradients, we show that the allocation of nitrogen in ribosomal proteins follows the environmental availability of nitrogen. The detailed amino acid distribution in orthologous positions of protein alignments in the different species along the nitrogen gradient further reinforces our results: it indicates that the pattern observed is not solely an effect of the temperature gradient, but that instead the availability of nitrogen plays a key role in shaping the distribution of nitrogen-rich amino acids (e.g., arginine). In the metagenomic era, these results point to the high potential of the integration of the perspectives of ecology and biogeochemistry in an evolutionary framework.

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- [2] S T Loiacono et al. 2012 *Env. Microbiol*. 14:5, 1272-1283

P5 – Silicon supply modifies C:N:P stoichiometry of grasses which in turn affects the decomposition of dead plant material

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Silicon is a non-essential element for plant growth. Nevertheless, it affects plant stress resistance and in some plants, such as grasses, it may substitute carbon (C) compounds in cell walls, thereby influencing C allocation patterns and biomass production. How variation in silicon supply over a narrow range affects nitrogen (N) and phosphorus (P) uptake by plants has also been investigated in some detail. However, little is known about effects on the stoichiometric relationships between C, N and P when silicon supply varies over a broader range. Here, we assessed the effect of silicon on aboveground biomass production and C:N:P stoichiometry of common reed, *Phragmites australis*, in a pot experiment in which three widely differing levels of silicon were supplied. This resulted in altered N:P ratios, whereas C:N ratios changed only slightly. Plant growth was slightly (but not significantly) enhanced at intermediate silicon supply levels but significantly decreased at high levels. Furthermore, silicon availability during plant growth affects mainly the microbial decomposition of litter, whereas higher trophic levels (invertebrate feeding) may control the overall effects of coarse particle mass loss during litter decomposition depending on the initial litter silicon content. But in contrast to other studies, our results show that the silicon content can explain the faster decay of plant material grown under higher silicon supply, as lower nutrient content and the higher ratios in stoichiometry would actually suggest an opposite result. Furthermore, invertebrate feeding is slightly negative affected by high silicon content of leaf litter.

Session 11 – Ecological theory – Concepts and models

Chairs: Hauke Reuter, Fred Jopp, Kurt Jax

O1 – Plant performance and grazing resistance - the synthesis of two concepts based on functional traits

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Plant functional traits are increasingly used to reveal strategies and involved mechanisms of plant species behavior in response to their environment and to predict species compositional change along environmental gradients. The concept of plant performance offers a hierarchical framework in which performance traits und underlying functional traits convey a certain strategy of growth, reproduction and survival that lead to a particular outcome for each performance component. In their interaction performance traits establish plant fitness in response to the environment the plants live in.While multiple traits are tested for various types of disturbance a mechanistic framework linking traits with strategies and mechanisms they convey and allowing the prediction of resulting plant performance is still missing for most of disturbance types. On the example of grazing I here a) introduce the synthesis of the concept of plant performance with those of grazing resistance, b) propose grazing associated performance traits and introduce corresponding underlying functional traits and c) describe, how they convey grazing resistance based on empirical data and ecological theory for grasslands. Pitfalls and open questions in the application of functional traits necessary for the development of a predictive plant ecology will be discussed.

O2 – Emergent facilitation between competing prey mediated through a niche shifting top consumer

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It is widely believed that predation moderates interspecific competition and promotes prey diversity, if superior competitors are also more vulnerable to predation. However, in models of two prey sharing a resource and a predator, predator-mediated coexistence occurs only over narrow ranges of resource productivity. While many predators exhibit a shift in resource use during their ontogeny, this is commonly ignored by models. We therefore theoretically explored the consequences of diet shifts between juvenile and adult predator stages for coexistence of two competing prey, spanning a continuum from no to complete diet shift (each predator stage specializing on a different prey). We find that diet shifts create community feedbacks that generate a bottleneck in one predator stage, enhancing predation on the superior competitor and relaxing predation on the inferior competitor. Pronounced diet shifts therefore greatly enhance the range of resource productivities permitting prey coexistence. With pronounced diet shifts, coexistence occurs, however, as only one of two alternative states. Once lost, coexistence is not easily restored and a depauperate community persists.

O3 – Interactions between parasitism, predation, and intraspecific competition in a freshwater protist community assemblage

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Parasite infection of prey often has consequences for predator-prey dynamics and *vice versa*. For example, in many cases, parasites increase the vulnerability of prey to predators. If these parasites are unable to escape or to withstand being ingested along with their hosts, their increase of the rate at which predators ingest their hosts could subsequently lead to their own local extinction. Additionally, if the parasites cause infected individuals among prey to become inferior competitors relative to uninfected individuals, the parasites could eventually be excluded from the system even in the absence of predators. For these reasons, one might expect the prevalence of infection in the prey to decrease over time. However, it is also often the case that parasites can survive for extended periods outside of their hosts and that predators feed differentially on uninfected prey. Here one might expect the opposite trend – that the prevalence of infection in the prey will increase over time.

Using a series of laboratory microcosm experiments combined with mathematical simulations, we investigated how interactions between parasitism, predation, and intraspecific competition influence community structure and dynamics. In our study system, the bacterivorous ciliate, *Paramecium caudatum*, is fed upon by both the parasitic bacterium, *Holospora undulata*, and the predatory ciliate, *Didinium nasutum*. The life cycle of *H. undulata* consists of an infectious stage, wherein the parasite lyses its host cell and swims freely until taken up bya new host, and a reproductive stage, wherein it proceeds to divide within the micronucleus and either gets allocated among the host's daughter cells or re-enters the infectious stage. We quantified: (1) the extent of synergism between the effects of *H. undulata* and *D. nasutum* on the population dynamics of *P. caudatum*, (2) the functional response of *D. nasutum* on *P. caudatum* in the presence and absence of *H. undulata*, and (3) the prevalence of infection by *H. undulata* over time in the population of *P. caudatum* with and without *D. nasutum*. Our results reveal the advantages and importance of incorporating trait-mediation and non-additive effects when modeling trophic dynamics and assessing community persistence.

O4 – Some like it hot... Others not. Population and community effects of temperature and habitat size in protist microcosms

Marco Plebani[1], Dennis Hansen[1], Owen Petchey[1]

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Temperature affects individual metabolic rate and numerous other individual characteristics, such as growth, feeding and mortality. Changes in these characteristics can impact interspecific interactions, population dynamics, and community structure. Each of these ecological properties is also affected by habitat size, yet there is no or little information about the joint effects of temperature and habitat size. We performed a factorial microbial microcosm experiment to assess the effect of temperature (8 to 29°C in 12 steps) and habitat size (small and larger) on population dynamics of monocultures and species in competition. Two ciliate species were used: Paramecium caudatum and Colpidium striatum, both bacterivores. Higher temperatures caused higher carrying capacity for Paramecium, whereas Colpidium carrying capacity was constant until a threshold, beyond which it declined precipitously. Interestingly, the threshold temperature depended on habitat size.
The outcome of competition was reversed along the temperature gradient, with no clear effect of, or interaction with, habitat size.
We will present mechanistic models aimed at describing the interplay between temperature, habitat size, and the strength of interspecific interactions in ecological communities.

O5 – Allometric theory - from feeding rates towards the big issues

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Many services and functions of ecosystems are the achievement of the local food webs. Each species contributes to the system’s emergent properties. However, the net effect of losing a predator species can be positive, negative or neutral, depending on the context and the species-specific properties. These so called identity effects appear to be idiosyncratic and render the consequences of random species loss on ecosystem functioning and services unpredictable.
The allometric theory of ecology provides a universal theoretical framework to study animal feeding relationships on several levels of complexity. Beginning on the level of single predator-prey pairs, we investigated feeding rates dependent on predator and prey body mass. We show that the classical view of distinct types of functional response can be substituted by a continuous allometric model. By applying these empirically derived body mass constraints on feeding rates we simulate differentiated predator identities. In the context of a generalist predator community, the allometric model emerges realistic properties - like niche complementarity and intraguild predation - resulting in interaction strengths that are qualitatively and quantitatively comparable to microcosm experiments (Schneider et al. 2012). Body-mass mediated intraguild predation affects other predators negatively, which may result in a positive net effect on the shared basal resource. Thus, the allometric model sucessfully simulates the highly variable identity effects that we observe in nature.
We finally use these realistic properties of the allometric model to investigate the correlation of predator diversity and ecosystem functioning in a large-scale simulation of unprecedented realism.

Thus, allometric theory allows bridging the gap between the mechanisms of trophic predator-prey interactions and the complex processes within highly diverse food webs.

- Schneider et al. 2012 Ecol. Lett. 15:436

O6 – Ecosystem functioning and different measures of biodiversity under stress

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Increases of ecosystem functioning with increasing species richness are well documented for stable or non-stressed systems. Other measures of biodiversity than species richness are very little studied. This is due to different benefits of species richness manipulations in contrast to manipulations of other aspects of biodiversity. Most importantly, species richness is easy to quantify in installed, manipulated and observed experimental studies. Further it does not require cost-intensive sequencing techniques or markers like measurements of genetic diversity. We report on an experimental study with 64 algae species in which we used different measures of biodiversity (species richness, number of SNPs, phylogenetic diversity). These measures showed overall similar patters of increasing ecosystem functioning along the diversity gradient. Additionally, within the same species richness level increases in genetic and phylogenetic diverstiy lead to increases of ecosystem functioning. Together, this may indicate a more precise measurement of diversity with these gradients since they are continuous and not additive as species richness. However, as natural ecosystems are subject to environmental fluctuations we further investigated the performance of ecosystem functioning along two different stress gradients (salt and temperature). We show that with increasing stress intensity, the increase of ecosystem functioning with diversity is lost. Here again the different measurements of diversity showed similar patterns.

O7 – Degradation patterns in a semi-arid savanna: how climate change affects the response to livestock grazing

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Drylands worldwide are exposed to a highly variable environment and face a great risk of degradation. Global climate change patterns that involve increased temperature or more variable precipitation will likely increase this risk. Thus, sustainable land use of drylands, e.g. by livestock grazing, requires careful planning and detailed knowledge of the system dynamics. However, the responses of ecosystems towards changes in climate or land use intensity are often non-linear and therefore difficult to predict.
A suitable way to assess changing dynamics of complex systems is the development and application of simulation models. The high interdependence of water and vegetation in water-limited ecosystems requires the incorporation of key feedback mechanisms between these two components. Additionally, the response of different plant types, e.g. to water stress, must be adequately resolved to account for changes in plant community composition. At the same time, parameter acquisition has to be feasible if the model is intended to be applied to various sites and to draw generic conclusions.
This task was addressed by developing the spatially explicit savanna model EcoHyD, which strikes a compromise between abstracting to keep its data needs low, and resolving processes where necessary. We will show how degradation patterns of a typical semi-arid savanna caused by high grazing pressure might change under future climate conditions. While presently a degraded state is often characterized by encroaching shrub species, this is likely to change in the future, which necessitates a revision of current indicators of early degradation. In addition, we will present an outlook to the representation of various response types in the model towards different sources of stress.

O8 – TreeMig-Aval: A spatially explicit forest-landscape model including snow avalanches

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Snow avalanches strongly influence mountain forests and pose a substantial hazard to human settlements. However, forests can influence the release probability of avalanches, leading to positive feedbacks between forests and avalanches. The strength and effects of these feedbacks may change under future environmental conditions, and can make planning of future forest management difficult. Dynamic models are useful tools to study feedbacks and their complex interactions with the environment, and can provide scenario analyses for forest management planning.
We coupled a new probabilistic avalanche module to a forest-landscape model, to study changes in forest composition, feedback effects, and avalanche occurrence under environmental changes. The combination of forest and avalanche dynamics in the same model is challenging due to the different

temporal and spatial scales involved, and an overall increase in model complexity compared to the forest model alone.
We present the integrated model TreeMig-Aval, and discuss model behavior, complexity, and the sensitivity of the simulated feedback to environmental drivers. We investigated the following questions: (a) Can the combined avalanche-forest model produce plausible results despite the scale differences? (b) Is the explicit simulation of the feedback in time necessary, or could the model be simplified by using forest conditions averaged over time for avalanche predictions? (c) Is the spatially explicit simulation of the avalanches required, or could the model be simplified by using spatially averaged avalanche occurrence for forest predictions?
Our results show that TreeMig-Aval produces plausible results at a resolution of 25m, with yearly time steps, and that a yearly link between forests and avalanches is indeed required. Further, we found that a spatially explicit representation of the forest-avalanche feedback is crucial for an accurate representation of species composition and spatial patterns in mountain forests.

O9 – Perspectives in Modelling Spatial Processes in Ecology

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The investigation of spatial heterogeneity and its effects on biodiversity and community dynamics, which had long been emphasised as being the 'last frontier' in ecology, is now getting part of main stream ecology. In ecological studies it is considered as State-of-the-Art to include a large variety of different aspects relating to the information of the individual's whereabouts, the connection to life-history processes, the effects on the species' interactions and also how this relates to higher level properties such as population or community distribution. Today, we accept, that including information on spatial processes relates studies closer to the available knowledge on the biology of species, thus often reducing zero-dimensional analyses to more theoretical concepts. Besides the elaboration of theoretical concepts the advances in technological developments and the development of appropriate software and modelling tools have contributed much to the present state.
However, especially for ecological modelling still many challenges exist when it comes to incorporating space. Examples are the combination of static statistical approaches in landscape analyses, distribution models and habitat suitability on the one side with dynamic models representing life-cycles and interactions in biological communities on the other side. Also cross-level research such as the relation of single species reactions to heterogeneous environments with biodiversity aspects and community dynamics constitute a continuous challenge.
In our presentation we want to point out the ongoing progress in the concepts and the modelling of spatial heterogeneous dynamics of species and corresponding community reactions. We also like to highlight important current developments that are capable to overcome existing shortcomings.

P1 - Some like it hot (... Others don't)

Marco Plebani[1], Dennis Hansen[1], Owen Petchey[1]

[1]University of Zurich, Zurich, CH

Both temperature and habitat size affect ecological processes, yet their joint effects are largely overlooked. Using a factorial microcosm experiment, I assessed the effects of a temperature gradient (8 to 29°C) and habitat size (small and larger) on the population dynamics of Paramecium caudatum and Colpidium striatum, both in monocultures and in competition. Paramecium carrying capacity increased with temperature; Colpidium carrying capacity was constant until a threshold, beyond which it declined precipitously: the threshold temperature depended on habitat size. The outcome of competition was reversed along the temperature gradient, with no clear effect of habitat size. Theoretical implications are discussed.

P2 – Phase Shifts in Coral Systems

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Coral reefs – ecosystems of extraordinary diversity, productivity and economical importance – are increasingly under threat. Perturbations of natural (e.g. extreme increases of sea surface temperatures) and anthropogenic (e.g. destructive fishing techniques) origin often have devastating effects on these unique ecosystems, especially if they occur simultaneously and amplify each other's impact. In high frequencies such disturbances undermine the reef's resilience and do not allow for recovery, which in the long run might trigger a phase shift and create irreversible conditions.

Here we utilize a spatially explicit, individual-based model to analyse the development of phase shifts in coral systems. Dynamics of the virtual benthic reef community, comprising scleractinian corals and algae, are mainly driven by interactions between competing organisms under different environmental settings. Higher system properties, like population dynamics or community composition hence emerge through self-organisation processes. Recurrent extreme temperature events which triggered coral bleaching and mechanical disturbances exposed the community to a basic level of stress. In different scenarios we then impacted the virtual reef with additional perturbations to trigger phase shifts.

Results show that multiple stressors can create feedbacks which may not only shift the system into an alternative state, but lock it in these new conditions. Where the impact of a single perturbation might allow a continuity of a given benthic community, a superimposed disturbance can induce extinctions and a complete transformation of an ecosystem. Here, our findings may help to identify key processes, drivers and respective thresholds, responsible for changes in local situations and, hence to aid managers in decision making processes.

P3 – Inter-habitat connectivity for fishes in tropical coastal habitats - an individual-based model (IBM) approach

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Given the threatening effects of rapid climate change and anthropogenic stress on coastal ecosystems worldwide, improved management is urgently needed to ensure sustainable use of natural resources. To date, a widely recommended management option is the implementation of marine protected areas (MPAs). However, only one third of all MPAs currently meet their management goals due to significant gaps in the ecological science of no-take reserves, particularly in terms of connectivity. Connectivity is known to significantly influence biodiversity and ecosystem functioning and is a common consideration in conservation planning. Movement of organisms, in particular fishes, is an integral part of connectivity in marine seascapes and fundamental to successful conservation. It is therefore important to identify essential fish habitats and improve the understanding of the species-habitat relationships of key species. The aim of this study is to apply an integrated approach combining quantitative movement studies using underwater visual surveys and hydro-acoustic tracking techniques with a spatially-explicit, multi-species individual-based model (IBM). The model will integrate key life history features of fish species representing different functional groups and spatial representations of the environment (habitat structure). Model-based analysis will enable forecasts and evaluations of consequences of changes in habitat structure or resource distribution and show effects of different management options. Thus, the model may contribute to the development of effective and sustainable management strategies of MPAs.

Session 12 – Ecophysiology of renewable raw material: Soil-plant-atmosphere interactions

Chairs: Maik Veste, Werner B. Herppich

O1 – An assessment of soil carbon sequestration under *Miscanthus* x *giganteus* on two spatial scales

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In recent years the use of biomass for energy production has become an increasingly important measure of mitigating global change. While national and international legislation strongly advocate the further development of the bioenergy sector, the scientific debate has been inconclusive. Recent life-cycle analyses on the bioenergy production chain have shown that bioenergy crops have a much lower GHG saving potential than initially assumed and can even act as a GHG source. Direct and indirect GHG emissions from land-use change can potentially require up to centuries of bioenergy use to see benefits. A possible solution is to use perennial energy crops such as willow or *Miscanthus*. Compared to annual crops such as oil-seed rape, perennial crops offer a range of environmental benefits, minimising initial GHG emissions and promoting soil carbon sequestration, thereby increasing their global change mitigation potential. Recent research on experimental fields has shown a high soil carbon sequestration potential across Europe; however, it can be expected that sequestration rates will differ on commercial plantations.

The aim of this study was to assess soil carbon sequestration as well as influencing factors under commercial *Miscanthus* plantations. An initial survey was conducted on 16 farms in south-east Ireland using the ^{13}C natural abundance method to identify *Miscanthus*-derived carbon stocks. Carbon sequestration ranged from 0 to 1.75 Mg ha^{-1} yr^{-1}. Mixed effects modelling identified former land-use (grassland or tillage), initial soil organic carbon content, and pH as main explanatory variables for changes in *Miscanthus*-derived carbon. A comparison with the adjacent former land-use also showed that soil organic carbon losses due to land-use change were not significant.

At the field scale, a significant number of commercial *Miscanthus* plantations showed a high number of large open patches. Significantly lower carbon sequestration rates in the open patches compared to adjacent high density *Miscanthus* patches was measured (1.51 *±0.31* Mg ha^{-1} and 2.78 *±0.25* Mg ha^{-1}, respectively). Using patch size data recorded along transects in a subplot of fields, a GIS model revealed losses in carbon sequestration on a field scale with a mean reduction in soil carbon sequestration of 9.71 *±19.89* %.

O2 – Solid biofuels from rewetted fens: Combustibility and yield of *Phragmites australis* at different sites and harvest times in NE Germany

Claudia Oehmke[1]

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The drainage of peatlands for agriculture in Western Pomerania (NE Germany) causes an enormous amount of greenhouse gas emissions. Conversely, rewetting of fen peatlands preserves peat soils as a carbon sink. At the same time, plant biomass from the surface vegetation of such sites can serve as a regional renewable resource for bio-energy production and other uses.
Phragmites australis forms large mono-dominant stands in rewetted fens of Western Pomerania. Studies from Northern Europe indicate that *Phragmites* harvested in winter is more suitable for combustion than straw or common energy crops like *Miscanthus*, because the winter weather leaches nutrients and other combustion-relevant compounds from the dead stalks. Additionally, reed plants relocate a considerable amount of them into the rhizomes after the vegetation period. On the other hand, it seems that a late harvest can lead to biomass losses. However, the details of how site conditions and harvest dates affect the combustion quality and yield of *Phragmites* are still largely unclear, particularly with reference to rewetted fen soils. Important combustion characteristics like ash deformation temperature, ash content, calorific value, and gas emissions are defined by the content of N, S, P, Cl, Ca, Mg and K in the aboveground biomass.
In this study we investigated the effect of water level, soil nutrients, alkalinity, and salinity on the chemical composition and yield of *Phragmites* growing on rewetted fen soils. Additionally, we studied the same *Phragmites*-stands at different harvest dates in autumn and winter. According to our preliminary results, readily soluble elements like Cl and K comprise less than 0,1% of the dry weight of late-harvest reed biomass. The Cl contents of biomass from brackish and non-brackish sites are equally low after the winter, while they still vary in the autumn. This suggests that leaching evens out at least some site-related differences in chemical composition of reed biomass. The contents of less soluble elements like N and P also decrease, but to a lesser degree. We assume that their decrease results less from leaching than from their being relocated to the roots of the plants at the end of the growing season, and that their contents reflect site-related differences even in late-harvest biomass.

O3 – Soil carbon sequestration in young alley-cropping systems composed of fast-growing tree species, Brandenburg, Germany

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Establishment of alley-cropping system causes changes in soil carbon and is generally seen as a viable land-use practice for carbon sequestration. The extent to which carbon is sequestered varies between alley-cropping systems, and depends on species composition, soil types and on the extent of physical protection of carbon within soil aggregates. Differentiation into labile and stable carbon pools may provide an insight into short-term changes in soil carbon related to ecosystem management. This study aims to evaluate total, stable and labile carbon pools, litter production and decomposition, and soil CO2 flux at young alley-cropping systems in Brandenburg, Germany. The alley-cropping system was established in 2010 on agricultural field near town Forst. The system presents strips of fast growing tree species: black locust (*Robinia pseudoacacia* L.), poplar (Populus Max 1) and alleys of maize and alfalfa. Composite soil samples were collected in 2012 from four depth layers: 0-3; 3-10; 10-30 and 30-60cm. Soil carbon was assessed by measuring total carbon as well as carbon fractions differing in decomposition rates. For this purpose soil samples were fractionated into labile and recalcitrant soil-size fractions by wet-sieving: macro (>250 µm), micro (53-250 µm) and clay + silt (<53 µm). This was followed by determination of organic carbon and nitrogen by gas-chromatography. Labile carbon was also determined by measuring hot-water extractable carbon. Litter decomposition was evaluated by litter bags experiment. Soil CO2 flux was measured with LiCor automated device LI-8100A. The first results of the experiment will be presented.

O4 – Trace gas emissions in an agricultural morainal landscape - merely a question of fertilisation?

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The hilly morainal landscape of north-eastern Germany is characterized by a fine mosaic of erosion-induced soil types, currently dominated by the cultivation of energy crops such as maize. Mitigation benefits arising from fossil fuel substitution with energy crops may be offset by the emission of greenhouse gases (GHG) during cultivation. Apart from abiotic (e.g., temperature, moisture) and biotic factors (e.g., crop, microbes), exchange rates of CO_2, N_2O and CH_4 also depend on management practices, fertilization regime (type, amount) and soil type. However, the relative influence of the latter factors on GHG emissions and the overall climate impact of energy maize have yet to be determined.
In an interdisciplinary approach, the ZALF investigates the impact of various factors such as crop, fertilization and erosion-induced soil type on GHG fluxes and the carbon budget. Ecosystem respiration (R_{eco}) and net ecosystem exchange (NEE) were measured periodically using a dynamic closed chamber system. Measurement gaps of NEE were filled by modeling R_{eco} based on temperature and gross primary production based on photosynthetically active radiation. Fluxes of N_2O and CH_4 were measured using static closed chambers.
All investigated soil types were C sinks, storing up to 2.6 t C ha^{-1} yr^{-1}. As expected for well-drained soils, CH_4 emissions were negligible regardless of fertilization type and amount. N_2O emissions moderately increased with increasing levels of organic fertilization from 0.05 (non-fertilized control) to 2.8 kg N ha^{-1} yr^{-1} (200% of typical N level). Variability of N_2O emissions between erosion-induced soil types was greater than for differently fertilized treatments, ranging from 2.0 (non-eroded haplic luvisol) to 7.3 kg N ha^{-1} yr^{-1} (colluvic regosol).
An understanding of soil ecological processes such as erosion may therefore be just as important as fertilization in minimizing GHG emissions during energy crop cultivation in glacially shaped landscapes.

O5 – Water use efficiency of bioenergy crops - a comparison between black locust and giant knotweed

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The cultivation of fast-growing plants for energetic usage is a significant alternative in marginal lands in Europe. As the availability of water influences the primary production and therefore the biomass production significantly, a central role is played by the optimization of these processes through the species selection. Consequently, the introduction of new bioenergy crops requires additional physiological and ecological details about their water use efficiency.
The tree species black locust (*Robinia pseudoacacia* L.) and the new cultivar of giant knotweed, trademarked with the name “IGNISCUM basic” (*Fallopia sachalinensis* var. \`Igniscum´, Fam. *Polygonaceae*), that preferably can be used in burning units, have the potential to be cropped for bioenergy production.
Black locust is planted in Lusatia for the production of biomass in short-rotation plantations and agroforestry systems. Igniscum is a potential new bioenergy crop, which is characterized by a high annual biomass production. It can be harvested up to two times during the growing season.
In a lysimeter experiment under semi-controlled growth condition we compared the transpiration and biomass production of both species (black locust and IGNISCUM Basic). The water was supplied solely by an automatic irrigation system in relation to the volumetric soil water content (7%, 10%, and 14%) and water use efficiency at whole plant level is evaluated during the vegetation period.
The study encompasses ecophysiological investigations of the gas exchange on single leaves to evaluate the influence of the stomata regulation on the transpiration. We determined the biomass-transpiration relation and formulated the equation that describes the interaction between water use and biomass production. The calculated mean cumulative transpiration during the vegetation period for black locust, which was 240 (7%), 385 (10%) and 587 liters (14%), with a WUE of 2.41kg of dry biomass for each m^{-3} of water transpired.

P1 – Spatial and temporal variation of plant water status and growth of black locust (*Robinia pseudoacacia* L.) in agroforestry systems

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Short-rotation forestry and agroforestry systems have the potential to become an ecologically valuable and economically profitable land use alternative on marginal lands. Therefore, our project focuses on determining the water demand for biomass production of black locust in the Lusatia region (Eastern Germany). The area is characterized by relative low annual rainfall (560-600 mm/yr) and drought periods during spring and summer. Black locust (*Robinia pseudoacacia* L.) is planted in short rotation plantations as well as in agroforestry systems at reclaimed post-mining sites of the opencast mining area "Welzow Süd" and on a conventionally managed field near the town Forst (both study sites are located about 120 km to the south of Berlin). Due to mining activities the ground water table in "Welzow-Süd" is below 100 m, while on the field site in Forst the ground water table is about 2 m below the soil surface. Because of the water accessibility directly affecting the yield, it is crucial to identify the spatial variation of the soil water availability and its influence on black locust growth. The main question of this study is how the drought periods affect black locust's growth and recovery and about the drought mitigation effect obtainable by an accessible water table. The growth rate is estimate monthly by measuring the maximum high and the trunk diameter at 10 and 130 cm. Furthermore, several trees are equipped with dendrometers to record their diameter increment in daily intervals. The pre-dawn water potential for selected trees is evaluated periodically and used for quantifying the plant water stress and related to the growth pattern. Water availability and microclimatic condition are monitored continuously. Information gathered from the field data at the end of the vegetation period will be used to develop a growth model to link the soil water availability and plant water status with the growth rate of the trees.

P2 – Impact of drought stress on photosynthesis, transpiration and growth of black locust (*Robinia pseudoacacia* L.)

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Nowadays, there is an increasing interest in black locust (*Robinia pseudoacacia*) for the production of biomass for bioenergy in short-rotation plantations. As a pioneer tree species black locust grows under a wide range of site conditions and is known to be relatively drought tolerant compared to other temperate, deciduous tree species. In Central and Eastern Europe *Robina* is cultivated in a continental climate with an annual precipitation often below 600 mm. However, the native range of black locust in Northern America is classified by a humid to sub- humid climate with a mean annual precipitation of 1020 to 1830 mm. In order to evaluate its growth and ecophysiological performance to drought stress, we conducted an drought experiment. Two sets each with 13 seven year old cuttings of black locust were cultivated in 65 liters plastic pots at the von-Thünen-Insitute in Hamburg-Lohbrügge. The drought stress treatment was irrigated with water amounts between 0.75 to 2.0 liters per day subject to the respective climatic conditions. The well-watered plants were watered each day with not less than 4 liters. The H_2O and CO_2-gas exchange of leaves was measured with a minicuvette system and chlorophyll fluorescence was monitored with a pulse-modulated fluorometer Walz-PAM-2100. Stem circumferences above ground level of the pots and in breast height were determined at the beginning and at the end of the drought experiment. Net photosynthesis and transpiration was reduced by drought due to stomatal closure. To minimize transpiration on plant level leaf area was reduce by drastic leaf fall. Increasing temperature and vpd increased transpiration significantly from 0.68 to 3.6 mmol m^{-2} s^{-1} only in the well-watered plants, while in drought stressed plants it is 0.39 to 0.48 mmol m^{-2} s^{-1}. Mean electron transport rates ranged from 71-105 µmol m^{-2} s^{-1} in drought stressed plants to 113–136 µmol m^{-2} s^{-1} in the well-watered plants. The diameter growth of the drought stressed trees was reduced by 42%.

P3 – Influence of nitrogen fertilization on photosynthesis and leaf nitrogen content of leaves of poplar and willow plants in short rotation plantations

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The demand for bioenergy plants and renewable raw material will increase in the next decades. The sustainability of their production depends on conservation and appropriate use of natural water and nutrient resources in the respective ecosystems. The efficient use of nitrogen is important for maintaining or increasing biomass yields and reducing environmental impacts in short-rotation plantations. In our experiment, we identified the effect of nitrogen fertilization on chlorophyll content, leaf nitrogen content and photosynthetic performance of poplars (*Populus maximovizcii* × *P. nigra* clone max 4) and willows (*Salix viminalis* clone Inger) growing at different nitrogen levels (0, 25, 50 and 75 kg N/ha year) in a field trial at the Institute for Agricultural Engineering in Potsdam-Bornim (Germany). Photosynthetic performance of single leaves was determined with a pulse-modulated fluorometer. Furthermore, three leaves were selected for photosynthetic light dependency measurement. Chlorophyll content of individual leaves were measured with a Yara-N-tester and related to the measured electron transport rate. A mixed sample of leaves were dried and analysed with an element analyser for their carbon and nitrogen contents. Mean electron transport rate (ETR) of poplar leaves showed a high variation ranging between 69.7 +/- 22.4 and 125.6 +/- 30.5 µmol $m^{-2}s^{-1}$, whereas, in willows, ETR was between 145.6 +/- 38.1 µmol $m^{-2}s^{-1}$ and 186.2 +/- 20.8 µmol $m^{-2}s^{-1}$. In poplars electron transport rates linearly related to the chlorophyll content as measured with the Yara-N-Tester. However, no significant influence of the nitrogen treatment on photosynthesis, and chlorophyll and nitrogen content could be observed for both tree species.

P4 – Carbon sequestration under short rotation coppices of poplar trees compared to conventional arable systems

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Recently, there is a considerable interest in assessment of carbon (C) sequestration, which can help prevent the global climate change by enhancing the C storage in soils and in trees, and by reduction emissions of CO_2. Short rotation coppices (SRC) with fast growing tree species appear to be a promising way for C sequestration and additionally for bioenergy production compared to conventional agriculture. In this paper an attempt is made to investigate the differences in C storage in soils under conventional agriculture practices and SRC of poplar (*Populus* sp.) in the Hessia region. The 3 years old SRC with rotation (cutting after 1, 2, and 3 years) and long-term cultivated agricultural lands with plant rotation: barley-rape-wheat were investigated. At each field soil samples were collected at three different depths: 0-10, 10-30 and 30-60 cm. First results demonstrate a higher C accumulation in deeper soil layers already after 3 years of growing SRC compared to the conventional agricultural practices. Moreover, there has been noticed greater C enrichment in soils under the oldest poplar plantation. Hot water extractable carbon (HWC) that represents the labile fraction of SOC was the highest in the oldest poplar plantation (454 mg kg^{-1} at the 0-10 cm depth) and was higher than in long-term cultivated arable soils (318 mg kg^{-1} at the 0-10 cm depth). Nevertheless, more research is needed on the long-term effects of SRC and on the sustainability of effects after return to their former conventional arable use.

Session 13 – Ecosystem services

Chairs: Joern Fischer, Josef Settele

O1 – Global food security, biodiversity conservation and the future of agricultural intensification

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Under the current scenario of rapid human population increase, achieving efficient and productive agricultural land use while conserving biodiversity is a global challenge. There is an ongoing debate whether land for nature and for production should be segregated (land sparing) or integrated on the same land (land sharing, wildlife-friendly farming). While recent studies argue for agricultural intensification in a land sparing approach, we suggest here that it fails to account for real-world complexity. We argue that agriculture practiced under smallholder farmer-dominated landscapes and not large-scale farming, is currently the backbone of global food security in the developing world. Furthermore, contemporary food usage is inefficient with one third wasted and a further third used inefficiently to feed livestock and that conventional intensification causes often overlooked environmental costs. A major argument for wildlife friendly farming and agroecological intensification is that crucial ecosystem services are provided by ''planned'' and ''associated'' biodiversity, whereas the land sparing concept implies that biodiversity in agroecosystems is functionally negligible. However, loss of biological control can result in dramatic increases of pest densities, pollinator services affect a third of global human food supply, and inappropriate agricultural management can lead to environmental degradation. Hence, the true value of functional biodiversity on the farm is often inadequately acknowledged or understood, while conventional intensification tends to disrupt beneficial functions of biodiversity. In conclusion, linking agricultural intensification with biodiversity conservation and hunger reduction requires well-informed regional and targeted solutions, something which the land sparing vs sharing debate has failed to achieve so far.

O2 – Integrative ecosystem service assessment in irrigated rice production systems in south-east Asia

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The LEGATO project (www.legato-project.net) aims at, amongst others, quantifying the interrelations between ecosystem functions (ESF) and ecosystem services (ESS) in irrigated rice agricultural systems in south-east Asia. Effects of changing land use strategies on ESF and biodiversity as well as impacts of different socio-cultural and economic settings and climate change impacts are assessed by integrating human and natural sciences within the project. The focus is on local as well as regional ESF (especially nutrient cycling), biodiversity and related supply of seven selected key ESS: a)regulating ESS: biocontrol, pollination; b) provisioning ESS: crop production; and c) cultural ESS: cultural identity, and landscape aesthetics. Moreover, income generation plays an important role. The participating European and Asian teams will define the specific ESS in the respective social and ecological context they are working in, beginning with stakeholder interviews and focus group discussions in the first phase of the project.

The LEGATO study design, including seven intensive test areas of 15x15 km² in Vietnam and on the Philippines, has been set up in order to be representative for different rice cultivation strategies with varying production intensities and under different socio-ecological conditions. Non-monetary and monetary as well as spatially explicit ESS evaluation methods are appliedin the test areas. The results will reveal service providing units (SPU) for the ESS mentioned above, including quantitative ESS supply assessments based on comprehensive field measurements, interviews and modeling results. Based on the Driver-Pressure-State-Impact-Response (DPSIR) model, the project consortium will be able to identify socio-ecological drivers of prevailing land use dynamics, the state of ESF, and resulting impacts on the supply of ESS. Finally, LEGATO will give recommendations for sustainable response actions based on ecological engineering principles under consideration of the multiple risks arising from global change.

O3 – Plant available silicon in South-east Asian rice paddy soils - relevance of land management and abiotic factors

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Background
Silicon (Si) is a crucial element in rice production. The plants absorb large amounts of Si, and recent research suggests that a sufficient supply of Si enhances crop yields. In addition, Si has gained increasing attention in biogeochemical literature. On a regional and global scale, the Si cycle interacts with the carbon cycle and is thus relevant for climate models. Furthermore, it was recently shown that land-use is a major factor for ecosystem Si fluxes.
Aims
In this study we assess the effects of rice paddy cultivation on the stocks of `reactive` Si fractions in mineral topsoils, which are presumed to largely contribute to plant-available Si and ecosystem Si fluxes. Furthermore we consider the relevance of abiotic factors (mineral assemblage; soil weathering status) and rice paddy management (differences in rice variety, crop rotation, and crop residue management) for these fractions.
Material and methods
Soils (top horizon of about 0-20 cm depth) were sampled from rice paddy fields and `control fields` (i.e., fields with alternative land-use such as forest and upland vegetable fields) in 2 mountainous and 5 lowland landscapes of contrasting geologic conditions in Vietnam and the Philippines. Ten paddy fields were sampled per landscape; the rice paddy management within landscapes differed when different farmers and/or communities managed the fields. We analysed the following fractions of reactive Si in the soils: acetate-extractable Si (dissolved and easily exchangeable Si), oxalate extractable Si (Si associated with poorly-ordered sesquioxides), Na_2CO_3 extractable Si (amorphous Si) and biogenic Si bodies (`phytoliths`).
Results and conclusions
First results show that contents of acetate-extractable Si in paddy topsoils can differ considerable within landscapes (i.e., by a factor of ≤4), but differences between landscapes are clearly more pronounced (i.e., factor of ≤10). Our preliminary conclusion is that easily exchangeable Si in paddy topsoils is mainly determined by abiotic factors, but land management can also exert significant effects. The outcomes of our study will help to enhance the knowledge base for sustainable Si management in rice paddy systems.

O4 – Indicating Cultural Ecosystem Services in rice production-shaped cultural landscapes in South East Asia

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In South East Asia extensive rice cultivation has shaped cultural landscapes, thus this prevalence of intensive agricultural activities characterizes the socio-ecological interrelationships. Recently, the increase of internal and external pressures such as, e.g., climate change, lifestyle changes, and degradation processes, causes problems for rice production, which is crucial for regional food supply. Not only is the agricultural productivity at risk, but as well non-material ecosystem functions and services. Major disturbances in agricultural processes are not limited to economic impacts only; the degradation of the supply functions of cultural landscapes could lead to a loss of cultural identity of societies. The resilience of these agro-ecosystems is thus closely linked to human well-being and societal stability. The project LEGATO (www.legato-project.net) aims to analyse respective influences in irrigated rice cropping systems in order to elaborate, test and implement appropriate tools for sustainable management in Vietnam and the Philippines. The complex functional linkages and feedback processes of their particular socio-ecological systems are evaluated by the assessment of locally-relevant Ecosystem Services (ES). Next to the analysis of drivers and pressures for Provisioning and Regulating ES particular attention is given to the role of Cultural Ecosystem Services (CES). CES are defined as *"non-material benefits people obtain from ecosystems*", accounting for a substantial share regarding human well-being. So far, there is a lack of insights into social and non-material functions of nature. Therefore LEGATO attaches particular importance to the role of two CES, landscape aesthetics and cultural identity. An important question is: What are cultural values and perceptions linked to the landscape that support the preservation of rice production systems? By the means of qualitative data collection we analyse differences in the landscape perception and local identity, and relevant indicators are derived depending on the respective context of the cultural landscapes in the cases study areas. The underlying hypothesis is that the appreciation of a landscape with its specific characteristics and the connectedness with a region supports landscape preservation and could facilitate the implementation of sustainable management tools for rice production.

O5 – JAGUAR – sustaining ecosystem services of the cultural landscapes in Germany and Japan

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Though being located in different biogeographical regions and being embedded in different socio-cultural paradigms, the societies of Japan and Germany exhibit corresponding behavior in terms of land

use. In this context, a comparative analysis of how exactly biodiversity, land use dynamics and ecosystem services in the cultural landscapes do interplay with each other, seems to be most suitable.

The recently started interdisciplinary project JAGUAR, sustainable futures for the cultural landscapes of Japan and Germany--biodiversity and ecosystem services as unifying concepts for the management of agricultural regions, is following this approach. The central idea is to quantify biological diversity and ecosystem services for land use types in such a way, that enables to develop adaptive management strategies for long-term nature conservation of the cultural landscapes in the two countries. As a core concept, for exemplary case-study regions service providing units (SPU) will be assigned that can be used to understand the impact of the socio-ecological dynamics on the biodiversity of the landscapes in focus. A wide array of modeling techniques, ranging from GIS-based approaches to bio-economic models to spatially-explicit techniques will allow for data integration and understanding of the emerging highly complex pattern. As demanded by the Intergovernmental Platform for Bioversity and Ecosystem Services (IPBES) and based on these spatially-explicit results we will be providing science-based decision support for stakeholders in Japan and Germany that can help to develop long-term strategies for management.

O6 – Spatial and Temporal Trends of Global Pollination Benefit

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Pollination is a well-studied and at the same time a threatened ecosystem service. A significant part of global crop production depends on or profits from pollination by animals. Using detailed information on global crop yields of 60 pollination dependent or profiting crops for 2000 as the most recent year available, we provide a map of global pollination benefits on a 5′ by 5′ latitude-longitude grid. The current spatial pattern of pollination benefits is only partly correlated with climate variables and the distribution of cropland. The resulting map of pollination benefits identifies hot spots of pollination benefits at sufficient detail to guide political decisions on where to protect pollination services by investing in structural diversity of land use. Additionally, we investigated the vulnerability of the national economies with respect to potential decline of pollination services as the portion of the (agricultural) economy depending on pollination benefits. While the general dependency of the agricultural economy on pollination seems to be stable from 1993 until 2009, we see increases in producer prices for pollination dependent crops, which we interpret as an early warning signal for a conflict between pollination service and other land uses at the global scale. Our spatially explicit analysis of global pollination benefit points to hot spots for the generation of pollination benefits and can serve as a base for further planning of land use, protection sites and agricultural policies for maintaining pollination services.

O7 – Valuing peatland ecosystem services for sustainable management

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Peatlands provide vital services to society, globally and nationally, especially with regards to the climate mitigation and adaptation. UK peatlands, covering 9.5% of the land area, also form the largest area of semi-natural habitat in the UK, hosting nationally and internationally important biodiversity and providing important water services. However, an estimated 80% UK peatlands have been damaged or converted to other land uses. Drained peatlands lead to significant anthropogenic CO_2 emissions, loss of biodiversity and water quality reduction.
Building on the IUCN UK Commission of Inquiry on Peatlands, we developed a transdisciplinary Valuing Nature Network to assess and value peatland ecosystem services. Using expert workshops with natural and socio-economic scientists, policy advisers, restoration practitioners and business representatives, we reviewed the evidence for spatio-temporal configuration of stocks and flows of services and derived new insights for assessing the value of peatlands for environmental decision-making. We identified the regulatory mechanisms necessary to develop new markets for peatland restoration and conservation, specifically through Payments for Ecosystem Services schemes. As an applied output we outlined a roadmap towards development of a peatland (carbon) code for sustainable management and potential voluntary carbon credits.

O8 – Ecosystem service-based livelihoods in West African agroforestry systems and their societal interdependencies

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As typical for West African countries, rural livelihood activities in Benin are substantially predicated on ecosystem services (ESSs) and biodiversity, such as rain-fed crop production and animal husbandry, as well as the collection of non-timber forest products (NTFPs) realized within an agroforestry system. However, due to climate and land use changes the availability and sustainable use of these ESSs are soaringly jeopardized.The conversion of savanna area into cultivated land for subsistence farming has steadily increased over the last decades. In addition, economic-driven management decisions like the progressive promotion of cash crops (e.g. cotton) by the Beninese government, as well as the international policy-driven demand for cultivable area has led to shifts in traditional land management and cultivation techniques. Hence, local land management has to cope with articulate trade-offs concerning the concurrent satisfaction of local subsistence needs of vulnerable local communities, and the (inter-)national demand for land. In order to design appropriate management strategies aiming at maintaining ESSs-based livelihoods in West African agroforestry systems, asufficient understanding of the interdependencies between ESSs provision, usage and socio-economic, ecological and political drivers of change applying at different temporal, spatial and societal / governance scales is needed.

Adopting this, we can reframe West African agroforestry systems as social-ecological systems serving as a promising model to assess the current and future impacts of these drivers on the maintenance of ESS-based livelihoods as a typical example for the huge area of African savannas in particular, and for the globally existing rural agroforestry systems in similar ecosystems in developing countries in general.

O9 – Exploring methods for a spatially explicit assessment of potential ecosystem functions for functional forest restoration in Central Chile

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Our study aims at identifying priority areas for functional forest restoration in the strongly deforested landscape of Central Chile according to their potential to enhance multiple forest-related ecosystem functions. The spatial distribution of forest ecosystems in the landscape is an important asset for the maintenance of regulating ecosystem services, for biodiversity and habitat functions as well as cultural services like recreation and tourism. Nevertheless, the feasability of forest restoration is limited by environmental conditions determining forest growth, as well as by competing land use options, which have to be taken into account to identify restoration areas with the potential to remain forested in the long term.
Therefore, in a first step, we analyzed factors influencing actual and historical forest occurrence, using multiple regressions to predict suitable areas for potential forest restoration according to significant ecological and socio-economical criteria. The result is a baseline map with a spatial gradient of forest restoration suitability.
In a second step, we carried out a spatial analysis of potential forest functions, based on the condition that the considered functions have to enhance or enable the restoration of the other functions. Therefore, we developed a conceptual model to integrate potential forest functions in a spatial multi-criteria analysis to map the overlap of several functions and to identify areas where the highest amount of forest functions would be achieved by a forest restoration intervention. Therefore, we explored and assessed methods for mapping potential forest functions. To finally determine priority areas for forest restoration, a combination of the two synthetical approaches - "restoration suitability" and "multiple forest function potential" - are conceptually planned in order to identify areas where the highest achievement of multiple forest functions enhancement meets the highest suitability for restoration and long-term forest maintenance.

O10 – Landscape effects on bird and rodent communities and seed predation to agriculture in Israel

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Natural habitats are providing habitat and resources for wildlife promoting ecosystem services or dis-services to adjacent agricultural fields. Biological pest control is an ecosystem service that can increase with proportions of natural habitats. In addition however pests like herbivorous insects or fruit and seed predators can be promoted by natural habitats in agricultural landscapes.
We studied the effects of the percentage of natural habitats and other landscape variables on bird and rodent community changes and seed predation in 20 almond orchards and 20 sunflower fields and their surrounding habitat. We hypothesized, that the percentage of natural habitat triggers a higher abundance of wildlife (birds and rodents), thus increasing seed predation both in the perennial almond and annual sunflower crop. We complement our study with exclusion experiments in almond orchards to disentangle seed predation by birds and rodents and to analyze if the effects of two seed predator taxa are additive or synergistic.
The abundance and diversity of birds and rodents could not be explained by the increasing percentage of natural habitat surrounding almond and sunflower fields. The accessibility for birds and rodents increased seed predation in almonds; the effect was even stronger when both birds and rodents were not excluded, hinting at ecological interactions.

We conclude that natural habitat in agricultural landscapes did not increase pests like seed predators in our study area the Judean Foothills, a Mediterranean agricultural landscape in central Israel.

O11 – Innovations for biodiversity assessments in planning and industry - integrating ecological models and ecosystem services

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At the University of Giessen, a project team aims at developing a new innovative system to make scientific methods and results of ecological research applicable for urban and landscape planning. Assisted by user-friendly software modules the novel system will bring together ecological modeling and the quantification of ecosystem services to facilitate considerations of sustainable planning. The project "ÖkoService" is funded by the Federal Ministry of Education and Research to evaluate the innovation potential of this system.
In urban and landscape planning, numerous rules and regulations exist concerning assessments of species, habitats and ecosystem functions. Furthermore, an increasing number of companies are recognizing the economic significance of environmentally responsible behaviour both for cost reduction and marketing purposes. However, existing procedures for assessing the impact of economic activities on ecosystems are costly, but they do not efficiently capture the complexity of interactions among humans, organisms and the abiotic environment. Our novel system will facilitate higher quality results at lower costs by (1) applying spatially explicit models of species and habitat distribution based on collated existing data, (2) supporting discussions among stakeholders by providing easy-to-grasp information on

the potential consequences of different land-management options and (3) providing coherent decision support by integrating biotic and abiotic aspects in the unifying concept of ecosystem services. Thus, we will develop comprehensive solutions for complex problems in a number of fields, e.g. landscape planning, agri-environmental policy or environmental protection in corporate operations.

O12 – Cultural ecosystem services: a literature review

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Cultural ecosystem services (CES) are best known as one of the four categories of the Millennium Ecosystem Assessment. They are mentioned in an increasing number of papers from various disciplines, but to date, no review is available of existing work on CES. To address this gap, we reviewed the current state of research on CES. Our aims were to identify recurrent research themes, and characterize different types of papers that deal with CES. Following an extensive literature search, we reviewed 104 papers explicitly dealing with CES. Using a cluster analysis, we identified four different types of papers: one set of papers dealt with desktop researches, a second set dealt with case-studies coming from different disciplines, using various methods including quantitative, spatial or participatory ones, a third set of papers dealt with assessing preferences and perceptions, and finally, a group of papers dealt with theoretical frameworks and concepts. For each paper, we asked a set of pre-defined questions relating to scope, methodology, and content. Fifty-eight percent of papers included case studies, twenty-five percent included strong conceptual elements, and seventeen percent of papers were reviews. Papers originated from six different academic disciplines, namely biodiversity conservation and ecology, environmental management and policy making, agriculture and forestry, economics, geography, and social sciences. Qualitative, quantitative and mixed methodologies were used regardless of discipline, and across all scales, with a preference for mixed and qualitative methods rather than quantitative ones. Key challenges for CES research in the future relate to improving methods for their valuation, improving linkages between disciplines, and more clearly articulating policy implications. We reach three main conclusions. First, CES can serve as a bridge between different disciplines and research communities. Second, CES offer one of the most convincing arguments for conservation and enhance the dialogue with practitioners from various backgrounds. Third, CES have the potential to trigger the evolution of the ecosystem services framework in a direction that engages people and accounts for social values. Based on current trends, we anticipate a major wave of progress in the evolution of research on cultural ecosystem services in the following years.

O13 – Ecosystem Services and Ethics: Challenges and opportunities

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The ecosystem services (ES) concept has proved to be productive in many fields, such as conservation biology, landscape planning, or ecosystem assessments. It also increasingly finds its way into different policy fields, as manifested for instance by the new EU biodiversity strategy. A major strength of the concept is that it demonstrates how human well-being is dependent on nature; it shows that the neglect of such dependencies has negative consequences on human well-being *and* the economy. As ecosystem services essentially refer to human needs and interests, values are a necessary element to consider when dealing with the concept in practice. As a result, in using the concept there is a need to be clear about what these different dimensions of value are, and be aware of the possible ethical issues that might be associated with the concept. Several ethical concerns with respect to applying the ES concept have been raised. Some of them refer to questions as to which conservation values are included and which are excluded when using the ES concept, or in which way the ecosystem services concept might either diminish or increase social injustices between those people who provide ES (and pay the costs) and those who benefit from them.

The presentation, based on results from a recent workshop on ecosystem services and ethics, will discuss some major ethical challenges related to applying the ecosystem services concept. It will then present how improved transparency in the use of the ecosystem service concept can contribute to using its strengths without succumbing to possible drawbacks arising from ethical problems that are associated with it.

O14 – Framing Societal Relevance of Biodiversity - The Concept of Ecosystem Services

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The interactions of biodiversity and societal actions, structures and processes are a priority topic within the international scientific and policy debate. These interactions are complex necessitating an integrative research approach. Addressing this issue the ecosystem service approach has gained a lot of attention lately, as it interlinks ecosystems with the benefits humans derive from them. However, many questions still remain unanswered calling for more emphasis on the conceptual work. We define ecosystem services to be part of a social-ecological system supporting society with biodiversity driven ecosystem services.

We present here the results of the conceptual work on social-ecological systems and ecosystem services within the Biodiversity and Climate Research Center BiK-F. We argue that not only species provide ecosystem services but rather biotic interactions, both tight (mutualistic symbiosis and parasites) and loose (trophic dependencies, pollination, seed dispersal) interactions, make a crucial contribution. Interesting questions that arise from this aspect are how climate change influences biotic interactions in terms of the creation of novel communities where certain interactions may no longer occur while new relationships may emerge. We refer our work to the step of ecological assessment within the concept of ecosystem services. These include the three different steps: 1) Analysis of ecological core structures and processes of specific biotic interactions, 2) Knowledge of referred ecosystem function, 3) Identification of ecosystem service provider.

With our conceptual work we seek to contribute to the following questions: 1) Which biotic interaction provides/contributes to which ecosystem service? 2) How might climate change alter the provision of these ecosystem services (do they react in the same way or different)? 3) What are trade-offs and synergies?

O15 – Ecosystem services and sustainability: descriptive means, normative goals and societal transformations

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The ecosystem services concept is dynamic and it has engaged a number of different scientific domains during its 30 year history with resulting shifts of emphasis and focus. Moreover, the notion of "ecosystem services" has been used not simply as a descriptive tool (concept) for disinterested, objective science, but also to further several different normative goals (agendas). These agendas can be summarised as: the conservation of biodiversity, the active (efficient) management of ecosystems to ensure human well-being; and the desire for more equitable distribution of access to natural resources. Success in each of these three agendas (conservation, well-being and equity) is dependent on acknowledging their mutual interdependences. We argue here that aligning the (descriptive) ecosystem services concept with the broader (normative) agenda of sustainability provides a uniquely useful framework for understanding and managing human-ecosystem interactions.
In this paper we undertake a text analysis of existing ecosystem services research to map 1) how the ecosystem service concept has changed over time and 2) the extent to which this changing concept is aligned with the normative goals of sustainability. We provide a new conceptual model for ecosystem services research that frames the concept within an explicit sustainability agenda. We argue that such an explicit normative realignment of the ecosystem services, while important, is in itself insufficient if the concept is to become transformative. We must consider how new ecological and socio-economic understandings of human-ecosystem interactions can inform norms, behaviours and policies that break from the current dominant paradigm that is endangering ecological and human well-being.

P1 – Ant seed predation, pesticide applications and farmers' income from tropical multi-cropping gardens

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Tropical small-holder farmers rely on sustainable food production. Crop seed predation by ants can cause substantial yield loss and thereby generate high pesticide use, but quantitative evidence on the effects of pesticides on ant seed predation in agroecosystems is missing. We used field experiments and questionnaire-based surveys to assessthe effect of sown-seed predation on four crop species (cucumber, carrot, chili pepper, and eggplant) in 15 vegetable gardens and the resulting impacts on net income of farmers. Further, we used insecticide and herbicide applications commonly used to protect seeds, seedlings and plants to test their effect on ant seed predation. We found that the mean percentage of seeds removed per garden was 42%, 49.4%, 48% and 50.6% for cucumber, eggplant, chili and carrot, respectively, despite the farmers' pesticide applications. Ant seed predation halved the farmers' income after considering initial and operational costs. Pesticide treatments did not affect seed predation success or overall ant abundance, but had positive and negative effects on ant species-specific abundances. High overall ant abundance caused high seed predation rate in all gardens suggesting functional redundancy of ant species, compensating for species loss due to pesticides. Preferably, these

inefficient attempts to chemically control pests should be substituted by environmentally friendly and more sustainable practices, such as overseeding.

P2 – Spillover effects and importance of urban gardens for trap-nesting bees and wasps

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Urbanization causes the strongest changes to natural landscapes, modifying biodiversity and its patterns. However, even in a densely populated urban area, valuable resources for bees and wasps communities may be found.
Trap-nesting bees and wasps can be expected to reflect ecological changes through their species richness and ecological functions: pollination and predation.We investigated the spillover effects of trap-nesting bees, wasps and their natural enemies, as well as their diversity and abundance, in an urban-rural gradient around Lüneburg, Germany and the impacts of the spillover of these agriculturally subsidized insects to adjacent gardens. We expected that the movement of the bees, wasps and their enemies from agricultural areas to the gardens around them may affect the native population of these insects in these gardens. We also assume that gardens at the city edge adjacent to rape fields and rape fields adjacent to urban gardens have higher bee and wasp diversity than rape fields isolated from urban areas.
Standardized trap-nests were exposed from April-October 2011 in 24 sites comprising four habitats in a gradient from the city center to isolated rape fields. The results show that the gardens at the city's edge have the highest bee and wasp species diversity and abundance, benefiting the adjacent rape fields, but so far we could not observe the impacts of spillover from the rape fields at the city's edge on the native insect´s population of the adjacent gardens. These results already highlight the importance of gardens and green spaces in urban areas for insects' diversity and richness.

P3 – Effects of woody habitats on bee species richness and abundance in rice-dominated landscapes in the Philippines

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The LEGATO-project (http://www.legato-project.net/) addresses ecosystem services in agricultural systems in South East Asia that are of vital importance for the stability of ecosystems, but also for human well-being. One of these ecosystem services is pollination that is essential for the reproduction of major crop species and most wild plants.
The aim of this study is to investigate the importance of woody habitats in agricultural landscapes dominated by rice agro-ecosystems for bee pollinators.

The study plots are located in the Laguna region in a lowland rice-based production system in southern Luzon, Philippines. The sampling takes place in eight locations and in each location there are three plots: The first plot is a rice field adjacent to a woody habitat; the second plot is located in a rice field with no woody habitat in a 100 m radius and the third plot is inside the woody habitat with fallow vegetation, vegetable fields or occasionally grazed areas in the ground vegetation.
Two methods are used to sample the bees: First of all, there are transect walks in all of the plots. Each flower-visiting bee within the transect is caught and the visited flower is recorded.
As the second method we install trap nests that consist of plastic tubes filled with reed internodes. The reed internodes can be inhabited by bees, wasps and their natural enemies.
We expect to find a higher diversity and abundance of flower-visiting and trap-nesting bees in richly structured plots than in poorly structured rice fields. Additionally, we expect that there will be a higher complexity of interaction networks in richly structured plots for bees with their visited flower species and also for the trap-nesting bees and their natural enemies. Ecosystem services, such as pollination, may benefit from ecological engineering measures that enhance the availability of suitable habitats for bees and other beneficial insects, such as biocontrol agents, in rice production landscapes.

P4 – Direct payments for ecosystem services

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In poor countries with unclear administrative structures payments for ecosystem services often do not seem to reach the people who pay a cost for not using the ecosystem in the traditional, possibly not sustainable way. As a consequence of the unclear distribution of benefits from payments, some communities in Madagascar prefer to have the payments invested in parties rather than receiving them as financial support for the community. The preference might be caused by the risk that money has to be handed over to the president and may or may not be used in the interest of all community members, while parties are for everybody. In order to identify possible constellations under which payments arrive directly in the communities and are used for sustainable improvements of the peoples' livelihoods, we review publications of the last 10 years for examples.

Session 14 – Education for Sustainability and Environmental Citizenship

Chair: Franz X. Bogner

O1 – The 2-MEV model: Quantifying environmental attitudes and values in 21 languages

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For decades, adolescent attitudes and values towards nature and environment rarely were a focus of psychometric approaches. Therefore, factorised item battery had been previously developed by Bogner & Wilhelm (1996) and subsequently revised through its application to various pupil populations in Western Europe (author 1998, 2000; authors 1996, 1997, 1999; author et al. 2000). Finally, by means of factor analyses and structural equation modelling, a scale valid for the entire European sample was identified (Authors 1999, 2002). This scale quantifies aspects of ecological attitudes via first-order factors and is based upon a theory encapsulating ecological attitude-sets in two orthogonal higher-order factors (values): Utilisation (U) and Preservation (P). The two-factor Model of Environmental Values (2-MEV) was formalised as determined by one's position on two orthogonal dimensions, a biocentric dimension that reflects conservation and protection of the environment (Preservation); and an anthropocentric dimension that reflects the utilisation of natural resources (Utilisation)" (Bogner & Wiseman 2006). The model itself was independently confirmed by three groups: Milfont & Dukitt 2004; Johnson & Monolis 2008; de Bauw, Donche & van Petegem, 2011) Besides measuring environmental attitudes it needs its linkage towards the relevant ecological behaviour as the disposition itself to act ecologically. Therefore, prosocial and moral considerations as motives for environmental conservation need specific consideration. Different research traditions converge in confirming moral norms and pro-social traits as key forces behind conservation. While their efficacy for behaviour is undisputed, their suitability for behaviour change nevertheless remains debatable. Additionally, a person's appreciation for nature is a most promising leverage for large-scale behaviour change, which is corroborated in its significance for people's ecological performance. At the same time, appreciation for nature might not draw negative consequences when it is promoted sensibly. Due to the pre-testing of all pupils involved in the intervention survey each individual positioning within the dichotomous preservational / utilitarian configuration is known. Therefore, all pupils were clustered according the Festinger's dissonance model (see authors 2003) into one of four quadrants according to their endorsement of both domains (P [preservation], U [utilisation]). Therefore, environmental attitude represents the extent to which people realize their personal conservation goals. Hoever, the apparent gap between individual attitude and behaviour might just represent an empirical chimera fed by poor measurement instruments. When behaviour is defined from a motivational point of view as an intent-oriented, goal-directed performance (e.g., Stern, 2000), i.e., as the behavioural means necessary to realize a specific attitudinal ambition, research did not only confirms that--based on the Rasch model--seemingly diverse types of activities like glass recycling and ownership of private solar panels belong to one class of actions (e.g., Kaiser 1998, 2006). Research has also found the attitude-behaviour gap to empirically disappear with proportions of explained behaviour variance as high as 95% (e.g., Kaiser et al., 2005), indicating that individual goal-directed behaviour simultaneously represents a measure of environmental attitude (Kaiser et al., 2007). As environmental attitude is not the reason behind but rather an individual's ecological overall performance itself (cf. Kaiser et al., 2008), attitude change necessarily implies behaviour change. Referring to environmental attitude as the motive behind shifts in people's ecological behaviour would accordingly be tautological and, thus, trivial as an explanation for change. (More details will be given within the presentation.)

O2 – Intervention of earth education programs with ecological values and actions

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Education has long been recognized as an important component of efforts to address environmental problems, providing the foundations of environmental awareness and concern about human impact (Bogner, 1998, 2004; Gigliotti, 1990). Many environmental education programs, however, focus primarily on environmental issues and problem-solving skills, failing to address the value and behavioral (action) components (Johnson & Manoli, 2011; Waliczek & Zajicek, 1997). Empirical studies provide clear evidence that addressing knowledge alone is not enough to lead to changes in behavior (Johnson & Manoli, 2008).Earth education programs are designed to include value and behavioral components, while still addressing ecological understandings (Wohlers & Johnson, 2003; Van Matre, 1991). Three earth education programs, Earthkeepers, Sunship Earth, and Sunship III, are the focus of this study. The environmental values and personal environmental actions of over 8,000 children ages 9-14 who participated in one of these programs were examined. Pre- and post- program measures included the Model of Ecological Values Scale (2-MEV) (Bogner & Wilhelm, 1996; Bogner & Wiseman, 1999; Johnson & Manoli, 2011) and the Program Follow-Through Survey (PFTS). Individual semi-structured interviews were also conducted with a small group of children who participated in all three programs over the course of four years. Results indicate that participants in earth education programs consistently change their environmental values and lessen their impact on our planet's systems of life by changing their personal actions.

O3 – Hands on your mind's models - Conceptions and interventions on the global carbon cycle in global warming

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Global warming is one of the greatest challenges facing humankind in the 21st century. Translating public concern for global warming into effective every-day actionrequires knowledge about the causes of climate change. An analysis of students' conceptions on global warming shows that they often differ from scientists' conceptions even after instruction.
The aim of our study is an evidence-based and theory-guided development of learning environments on the global carbon cycle and the human impacts on it as key aspects of global warming. Based on students conceptions we developed different learning environments using the model of educational reconstruction.
Based on students (18 yrs.) conceptions collected in an interview study (n=16) we developed different learning environments using the model of educational reconstruction and evaluated them in teaching experiments (n=24) and classroom observation (n=32). The data were gathered with video (teaching

experiments, classroom observation) and audio (interviews), transcribed and investigated by qualitative content analysis and metaphor analysis.
Guided by experientialism we found three thinking patterns of the causes of global warming.The analysis shows that all students – as well as scientists – discern between natural and man-made CO_2: But while scientists explain global warming with *man-made carbon flows*, students imagine the *CO_2 itself* to be *man-made* and with different properties than a*natural CO_2*. By uncovering the – mostly unconsciously – used schemata, we gave students access to their conceptions and let them experience their mental models. By discussing the consequences of their domain specific use of the schema they reconstructed their everyday-conceptions i. e. *Man-made and natural CO_2*to scientific concepts, i. e. *Man made and natural cause of carbon flow* by reflecting on and experiencing their mental model.

O4 – Young people's conceptions concerning bio-energy: new challenges in education with regard to renewable energy targets

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Nowadays climate change is one of the most serious ecological problems. The utilization of renewable energy is an environmentally responsible alternative to fossil fuels and nuclear energy; thereby bioenergy appears to be the main contributor at present (Offermann et al., 2011). However, in contrast to its great potential for future energy markets, bioenergyis still one of the less known and least popular forms of renewable energies amongst the general public (Rohracher, 2010). Especially young people seem to lack in-depth knowledge (Halder et al., 2011). A low social acceptance could set major barriers to a large scale introduction of renewable energies (Webler & Tuler, 2010) and a better awareness of the benefits of the energetic use of biomass is crucial to increase public support with regard to bioenergy. Thereby environmental education, especially at school seems to be a key factor. However bioenergy is a multi-faceted topic that is difficult for pupils to study, as well as for instructors to teach and appropriate communication strategies have to be developed. In so doing pre-conceptions should always be taken into account, since many years of research have thought us "that construction of new conceptions (learning) is possible only on the basis of already existing conceptions" (Duit, 1999, p. 275). Consequently the aim of this study was not only to assess pupils` content knowledge, but in particular to have a focus on their preconceptions by using concept maps. Altogether 255 pupils (lowest stratification level, aged 14 to 16) carried out concept maps with a focus on bioenergy. A content analysis could show that the majority of them were poorly informed about general aspects related to bioenergy. As a major alternative conception pupils have mistaken bioenergy as an umbrella term for different forms of renewable energies (primarily wind-, water-, and solar energy). Consequently we strongly suggest that teaching units with regard to bioenergy have to be integrated in existing curriculums. Thereby teachers should consider alternative conceptions to facilitate its correct understanding.
List of references is available from the author.

O5 – Students' perceptions of green genetic engineering*

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During the last decade, the cultivation of genetically modified food and its availability on the global market increased rapidly (Maghari & Ardekani, 2011). Thus, the general public is compelled to reflect about the cultivation and distribution of genetically modified plants and to face the emerging ethical, political and economic questions. Various studies investigate the attitudes and perceptions of consumers towards green genetic engineering and genetically modified food (e.g. Poortinga & Pidgeon, 2006). However, only few studies analysed the students' points of view on this socio-scientific issue. We investigated students' hopes and apprehensions regarding green genetic engineering. The design of the study is based on the mixed method approach (Johnson & Onwuegbuzie, 2004). We collected quantitative as well as qualitative data from Bavarian secondary school 10th graders. The students mentioned various hopes regarding green genetic engineering like economical and ecological aspects as well as the improvement of plant species and cultivation methods. However, most of them hoped that the worldwide production of foodstuffs could be increased to enhance the global food supply. In contrast to this, students were afraid of negative consequences on human health and unforeseeable long-term effects. Furthermore, many students mentioned apprehensions concerning the impact on the ecosystem and the potential displacement of native species. The results provide principles for the examination of the complex topic of green genetic engineering during biology lessons. Students' perceptions should be addressed in order to support them in evaluating green genetic engineering and in forming their own points of view.

*Funding: Bavarian StMUG, Oberfrankenstiftung, DFG (BO 944/4-4).

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O6 – Education for eco-friendly consumer behaviour in an authentic learning setting

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Most consumers are not aware of the close connection between environmental issues and their individual shopping decisions (Thøgersen, 1999). Therefore, raising the awareness of adolescents as consumers of the future and with considerable purchasing power and the ability to influence their families´ shopping behaviour (Bisonnette & Contento, 2001) seems well-appropriate. For this reason, agriculture, food and consumerism are regarded as suitable interdisciplinary subjects for teaching students about related environmental problems and sustainable consumer behaviour.
In our intervention-study, we tested in a quasi-experimental design the consumer behaviour concerning sustainability of 176 fifth graders. Our provided workstations covered agricultural issues and food production.We used the subscale "Consumer Behaviour" of the General Environmental Behaviour Scale (Kaiser, Oerke, & Bogner, 2007) in a pre-, post-, and follow-up test design to identify changes in the attitudes concerning ecologically-friendly consumer behaviour. First results show that there was an enhanced intention to behave eco-friendly after participation ($t(175) = -4.717$, $p < .0001$, $r = .34$). Due to the results of the follow-up test (ca. 7 weeks later), this effect was not persistent. Reasons will be discussed in detail.
Our results indicate that the students were well-aware of sustainable consumer behaviour after participation. The link of the topics to their daily life caught the students' eye to consider their way of life, but they could not implement it in their daily life. Comparable to health education it is, however, very important to start sustainable and environmental education at early ages.

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O7 – Environmental Education and Connectedness with Nature

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Our modern environmental problems are crucially interwoven with the humans' nature relationship (Frantz et al. 2005). Positive experiences while an individual spends time with nature may increase the individual's strength of connectedness (Schultz 2002). Few studies have examined the promotion of connectedness with nature. Therefore, our goal was (1) to examine differences in connectedness among a sample of children with differing ages and achievement levels and (2) to investigate whether environmental education can help improve and sustain connectedness with nature.
With a pre-, post- and retention test design, we assessed a comprehensive four-day environmental education programme on water at a field centre, using the Inclusion of Nature in Self (INS; Schultz 2002) scale to identify changes in connectedness with nature of 190 students, 9 to 10 years (younger students) and 11 to 13 years of age (older students).

We found that younger children and high achievers had higher connectedness to nature (INS) scores than older children and low achievers, respectively. The participation in environmental education resulted in a robust short-term increase in connectedness with nature in both age groups, though higher within the younger group (z = -3.57, p < .001, r = -.31), compared to the older students (z = -1.81, p = .036, r = -.24). Over the long-term only the younger students' connectedness remained sustained (z = -2.03, p = .021, r = -.17). A control group showed no significant differences between the test times.
We conclude that comprehensive environmental education allowing direct nature experiences can strengthen the feeling of inclusion with nature. Over the long term the programme was more effective for the younger students. This outcome should be considered for interventions, as strengthening connectedness to nature seems to be more sustainable before the age of 11.

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O8 – Media and climate-related responsible behaviour

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This research explores how television programs that focus on climate change issues impact German teenagers' actions regarding climate protection. Public discussions on climate change in Germany have focused on achieving a fundamental transformation of the relationship between society and the environment. Besides political/governmental adaptation or mitigation strategies to tackle global warming (e.g. technological innovations), significant transformations at the individual level have also been deliberated.
In this work, individuals indicate a willingness that societal change is necessary to address climate change. However, the gap between awareness, intended behavior and action-related behavior is still pronounced.
Public awareness has taken place significantly through media. In this context, television can be considered as the primary medium to gather information. With origins in media socialization literatures, this research interrogates how television carries, contests and communicates normative and cultural values of young adults, as deeply linked to their social reference systems ("peer-group").
Numerous studies on climate change in the media have asked if and how issues like environment, sustainability, and climate change have been represented in the media. Other studies have dealt with the question of media genesis of climate change over the past three decades and how the issues have been framed in media broadcasting. Largely, there has been a focus on print media, and television research has scarcely been considered in that context. In addition, little thought has been given to behavioral intent and patterns for climate protection and the connection with media use.
Therefore, I examine what influence media has on adolescent's behavior concerning climate issues. This is particularly important in terms of public broadcasting in Germany that has an educational mandate to inform and educate people about climate change and climate protection issues.

O9 – Environmental education at the zoological garden

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Facing a world of accelerating environmental threats and reduction in biodiversity zoos and aquariums have the responsibility to integrate environmental education and education for sustainability in their educational philosophy (WZACS 2005). Furthermore, zoo visits create positive emotional experiences that facilitate interest in animals and support conservation activities (Clayton et al. 2009). But there are surprisingly hardly studies about the cognitive and affective benefits of students out of environmental education programsin zoological gardens. Therefore we developed a self-guided environmental education program for 10th graders at the Zoo of Nuremberg.The students learn within marine mammal biology about the threat of the oceans (e.g. climate change, bioaccumulation) and the sustainable use and management of marine resources (e.g. sustainable fishery). Furthermore students get guidance for alternative activities (e.g. consume behaviour). Using a quasi-experimental study design with pre-, post- and retention test following issues shall be evaluated:

- Are moderate constructivist methods like learning at workstations and jigsaw groups suitable to support sustainable learning during a zoo visit?
- Does this education program strengthen and facilitate an emotional connectedness towards animals?
- To what extent can emotional connectedness towards animals affect the ecological behaviour of students?
- Zoos, NGOs and media use the polar bear as “climate ambassador”. But is the example of a charismatic flagship species suitable to explain complex ecological relationships. Are there any misconceptions of the students?

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O10 – Cognitive and emotional factors influencing adolescents' commitment to sustainable development - national and global perspectives

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Transforming our societies to achieve the goals of sustainable development and thus providing socially and ecologically secure living conditions for future generations will depend on a wide acceptance and support by the general public. Education is regarded as one major means to fostering the commitment of adolescents as future decision makers to contribute to this transformation towards sustainability both locally and globally. Based on Schwartz’ norm activation model we investigated psychological factors influencing adolescents’ commitment to engage in sustainable consumer behavior, citizenship and activism. To extend the predictive power of the model we integrated Schwartz’ theory of basic human values as well as various emotional variables. We currently conduct two quantitative questionnaire studies with about 1.000 tenth grade students throughout Northern Germany. Findings of both studies will allow for a comparison along two dichotomies: first, the national/global dichotomy in adolescents' behavioral commitments and second, commitments in socio-economic compared to ecological contexts. Selected results will be presented along with an outlook on educational implications to foster adolescents' commitment to act in favor of sustainable development.

Session 15 – Effects of habitat conversion and land-use intensification in the tropics on animal diversity and ecosystem functioning

Chairs: Marcell Peters, Ingolf Steffan-Dewenter

O1 – Cascading effects of tropical agroecosystem intensification on ant communities, ecosystem services/disservices and yield

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In tropical agroecosystems ants are key organisms which may drive complex direct and indirect interaction networks between crops and their pests and pathogens. In Indonesian cacao agroforests intensification has led to proliferation of disturbance-adapted dominant ant species. Dependent on presence and identity of the dominant species ant communities vary in species richness and composition and hence may differ in their effects on the crop plant. Until now most studies have focused on top-down effects on single pest species. But pest control is just one of many direct and indirect interactions by which predators affect crop plants. Therefore to assess the whole extent to which a particular predator community provides ecosystem services or disservices in agricultural ecosystems, the main response should be quantity and quality of yield.
We quantified ant community composition effects on pests and pathogens of cacao determining final yield using a highly replicated ant manipulation experiment in 15 smallholder cacao agroecosystems with four subplots each:1) Establishing the recently invasive dominant *Philidris* cf. *cordata* (high ant abundances; low evenness); 2) Colonization with the indigenous ant *Dolichoderus* sp. (high abundances ; intermediate evenness); 3) Excluding all ants; 4) Unmanipulated control treatment (intermediate abundances; high evenness).
Ants affected yield via a complex suite of direct and indirect interactions including sucking and chewing pod pests, leaf-herbivores and pathogens. Yield was highest in cacao with unmanipulated ant communities, while excluding ants decreased yield by 26%. Effect of dominant ants depended on species identity, with 28% yield losses in the case of *Philidris* and no significant losses in *Dolichoderus*. Our results suggest that major disservices were provided by the recently spread, but not the indigenous ant species and that prevalence of services over disservices appears to work best in species rich, more even ant communities.

O2 – Conciliating agricultural production and forest conservation: the case study of coffee production in Kodagu, India

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The importance of forest fragments in supporting ecosystem services and the benefits that the surrounding agricultural landscapes receives in terms of ecosystem services has obtained considerable recognition in recent years. We investigated the combined effect of distance from forest and forest size on visitor abundance at the coffee plantations. Since irrigation or rain had a dramatically different impact on flowering scale, we differentiated two contrasting scenarios in this landscape: local flowering, at the coffee plantation scale, occurred following irrigation and mass flowering, at the landscape scale, took place following rainfall. During a mass flowering event, visitor abundance at coffee flowers decreased with increasing distance to the nearest forest. In two of the pollinator species, with an increase in the size of the forest, the effect of distance from the forest decreased. These effects were not observed in coffee agro-forests that were irrigated since the abundance of bees was high irrespective of any other landscape or coffee agroforestry systems variables.

Our study emphasises the importance of social bees in coffee pollination and indicates that the quality of pollination services may depend on management practices as well as on the surrounding habitat structure. It shows the need for conserving large forest remnants even in landscapes with high densities of forest fragments. Raising awareness among coffee growers of the role of forest remnants and irrigation in pollinating coffee can potentially contribute to both forest conservation and improved coffee yields.

O3 – Linking land use change, biodiversity and ecosystem services in coffee management systems on Mount Kilimanjaro (Tanzania)

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Anthropogenic habitat disturbance and land use intensification have frequently been linked to a worldwide loss of biodiversity. However, the relation between biodiversity and the provision of ecosystem services remains still little understood. We analyzed if land use intensification in coffee management systems affects the diversity and abundance of pollinators and vertebrate insect predators (birds and bats) and tested if this response is reflected in the ecosystem services they provide. On the southern slopes of Mount Kilimanjaro (Tanzania), where *Coffea arabica* is the most important cash crop, we established single and combined pollinator and vertebrate exclosures on each of four plots of traditional homegardens of small-scale farmers, shaded coffee plantations and unshaded coffee plantations (total sample size = 180 coffee bushes). We quantified the ecosystem service of pollinators

by comparing the early fruitset of open pollinated flowers and pollinator exclosures and related it to pollinator diversity and flower visitation rates that were recorded during the coffee blossom. Pest control services of birds and bats were measured by assessing changes in arthropod communities, herbivore abundances and herbivory rates after six months outside and inside the vertebrate exclosures and were linked to the diversity and abundance of vertebrates. Finally, we tested the single and combined effect of pollination and pest control services for coffee production by comparing the late fruitset (after 6 months) and the quality of coffee seeds between exclosures and open controls. Our set up allows us not only to demonstrate how land use conversion influences the abundance and diversity of both pollinators and vertebrate insect predators and how these changes are linked to multiple ecosystem services, but also to disentangle the contribution of each functional group to crop production.

O4 – Niche partitioning and food web structure of riparian anuran communities: a comparison between primary and repeatedly logged forests in Borneo

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As virtually all anurans are carnivorous, they are expected to play an important role as top-down regulators of arthropods in places where they are diverse and abundant such as in Southeast Asian rainforests. Arthropods and especially ants are well known to play key roles in tropical ecosystems, such as pollination, seed dispersal and predation. Thus, abundant arthropod predators are likely to interact with these ecosystem services.

Our study took place within the framework of the SAFE project (**S**tability of **A**ltered **F**orest **E**cosystems) in Southeast Asia on the island of Borneo. We flushed stomachs of riparian anurans, which are the species-richest amphibian communities on Borneo. We collected the samples at night in both secondary and primary forests. In total we sampled more than 1000 individuals from 28 species. Prey items were identified to order level with the exception of ants that were identified to genus and assigned to morphospecies (or species where possible). From this dataset we were able to categorize the riparian anuran species into ant-specialists, ant-avoiders and generalists. In addition, we collected ecological data from the literature to assign the different ant taxa to certain ecological groups.

An unusually high number of over 226 ant morphospecies from 59 genera were found within the sampling area. The number of ant species within a single stomach sample differed between frog species, but generally ranged between 5 and 22. The composition of ant taxa eaten by the frogs together with their ecological characteristics revealed a strong niche partitioning for the foraging habitat of the anuran community: leaf litter, arboreal and generalist. We also identified differences in the food web structure between secondary and primary forests that can be used to further clarify the shift in ecological functioning in human modified forests.

O5 – Bats and Food Security

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Sustainable rice production is critical tofood security because it is a staple food especially in Asia. Effective biocontrol of major rice pests such as the White-Backed Planthopper (*Sogatella furcifera*; WBPH) is, hence, of eminent importance. Herewe use data from Thailand and an iterative modelling approach to quantify the importance of biological pest control by a common bat species (*Tadarida plicata*) on WBPH. For Thailand, we found that this single species may prevent rice loss of almost 500 tons per year, which is worth more than US$ 92,000 and can feed 4,400 people annually. When extrapolated across Asia in a spatially explicit approach, we found that the bat may secure food for up to 13,000 people per year. For the first time our results show the critical importance of bat pest control services in the current discussion of ecosystems sustaining food security and the reality of famines. We further provide a strong rationale for including functionally important populations, not just rare and endangered species, into the conservation management of human-dominated landscapes. Aspoverty is linked to insufficient access to food, sustaining functionally important populations may locally also contribute to poverty mitigation.

O6 – How much prey do frogs consume in a tropical rainforest? Quantifying a basic ecosystem function of a globally threatened taxon

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Facing global decline, it is crucial to understand the roles amphibians play in ecosystems for predictions of possible consequences on food webs and ecosystem services. We estimated the daily amount of prey consumed by a tropical anuran community in the lowland mixed-dipterocarp rainforest of the Ulu Temburong National Park in Brunei Darussalam (Borneo). Diet compositions of 714 individuals of 30 frog species were derived from stomach flushing samples. For quantification of prey consumption over time, we combined the information on diet spectra with abundance data on frogs and estimates of daily nutritional requirements. Actual prey uptake per day was tested for four species by following radio-tagged individuals and flushing stomachs before and after a 24 hour period of foraging in their natural habitat. Different digestion rates of hard and soft bodied prey items were corrected for by measuring digestion rates of such prey. Frogs densities along streams were surveyed and extrapolated to 1,064 individuals per km. According to our calculations, frogs are capable of consuming 44 g of prey dry mass per stream km and day, which results in a total consumption of more than 20 tons per year in the 49,000 ha national park. Social insects, ensiferans and beetles accounted for the largest fractions in the community's diet composition. Further we allocated prey species to the following functional groups, to assess the impact of amphibian predation on different trophic levels: predatory arthropods, omni-/detritivorous arthropods, “worms” and snails, other herbivorous insects, crabs and prawns, vertebrates, aerial insects and aquatic insects. Our results provide a rough estimate of total predation by

a tropical anuran community and suggest that frogs play an important role as predators of social insects and herbivorous insects in the rainforest food web.

P1 – Long term effects of land use on vegetation structure in savanna rangelands

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Intensive land use in form of heavy grazing has changed savanna landscapes worldwide. In particular, bush encroachment at the costs of palatable grasses and herbs is considered to be one of the most threatening forms of rangeland degradation affecting plant species richness and composition. This study examines the long term effects of land use on the cover and structure of the vegetation along a land use gradient in the savanna of the southern Kalahari, South Africa. Vegetation data of 10 years, 2001-2011, are compared with regard to changes in vegetation at four different grazing intensities (stocking rate, livestock/game). Results show that the extent of shrub encroachment differs largely across study sites in relation to land use. Interestingly, while the recruitment of Rhigozum trichotomum (one of the two major shrub encroachers in the study area) was high, we observed no recruitment of Acacia mellifera supporting the hypothesis of pulsed recruitment events in relation to rainfall.

P2 – Influence of habitat destruction and land use intensification of coffee plantations on ant communities on Mt. Kilimanjaro

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Ants are abundant and important elements of terrestrial ecosystems and provide a variety of ecological functions. Habitat destruction and the intensification of agriculture may lead to a loss of ant species and thereby to a loss of ecological functions. The relationship between the richness or composition of species communities and ecological functionality is still little understood, particularly in the species-rich ecosystems of the tropics. We analyzed the influence of land use intensification on coffee plantations in the lower montane ecosystems of Mt. Kilimanjaro on soil living ant communities and their functional diversity. A combination of leaf litter sampling, 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 and stable isotope analysis. In addition, we conducted bait experiments with sugar and mackerel to assess foraging rates of ants on coffee bushes ant their preferences for protein-fat-rich resources versus carbohydrate-rich resources. We present the relationship between species and functional richness of ant communities and show how both are affected by habitat destruction and increasing land use intensity.

P3 – Pattern and guild diversity of tree bark dwelling arthropods in a high altitude mountain forest in the tropics (Ecuador)

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In the course of our MACAG project (*Monitoring of Arthropods along Climate and Altitude Gradients*, see e.g. GfÖ 2009 Annual Meeting abstract), we are comparing assemblages of arthropod taxa sampled from (alive) tree bark by bark spray method in a standard procedure in Podocarpus NP in Ecuador from 2007-2009 along an altitudinal gradient from 1,000 to 3,000 m (347 trees from 29 plots). Here, we focus on the differences in diversity patterns and guilds compositions among beetles, harvestmen and pseudoscorpions in a climatic temperate zone of the tropics, the Paramo transition cloud (dwarf) forest at 3,000m asl, and in comparison with lower altitudinal levels.

In all three taxa, the bark dwelling species are mainly predators (presumably on top of the bark foodweb). Among the beetles, in general the species feeding on Collembola and Acari (the main grazers on bark, feeding on algae and cryptogames) are dominant, but at 3,000 m diversity is more limited, going along with changes in guild proportions and family composition. Nevertheless, exemplary studies on Steninae (Staphylinidae) show that barcoding technique and taxonomic studies based on genitalia significantly enlarge the number of species also in the'tropical temperate' zone, highlighting differences to temperate forest of higher latitudes. For Steninae and Pselaphinae, we are presenting a barcoding laboratory standard.

Among the exclusively predaceous harvestmen, species richness on bark is highest at 3,000 m, a pattern that can only be explained by the high three-dimensionality of the rough and epiphyte-rich bark in the cloud forests, giving shelter to these long-legged species of relatively big body size. The predaceous, tiny Pseudoscorpionida show very low diversity and abundance at 3,000 m, which is explained by the high precipitation and moisture in the dense bark epiphyte cover, preventing activity and predation. In this context, effects of body size and bark environment are discussed.

Session 16 – Emerging topics in Ecosystem Sciences: Impacts of Climate Change induced Changes in Phenology on Biogeochemical Cycles

Chairs: Hella Ahrends, Ansgar Kahmen

O1 – The biological basis of plant phenology

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Phenology is the visible expression of plant development. Plant control of development ensures gene flow and thus, evolution (no sex without synchrony), secures stress resistance before stress occurs (e.g. freezing resistance in autumn), and prevents plants from getting tricked by exceptionally warm weather at the wrong time (late winter/early spring). In this presentation, I will re-call the significance and control of phenology by plants, as opposed to popular concepts resting on external forcing of the seasonal life cycle of plants by temperature only. I will summarize the various cues and controls. For instance, spring phenology reflects the joint action of three factors: chilling requirement, photoperiod and actual temperature. Examples will be provided for how habitat type and life history traits of plants lead to differential employment of various triggers. This field has received great attention in the light of global warming and some strong phenological signals in mostly opportunistic taxa (exotic ornamental or domesticated trees), but is possibly the most difficult to handle experimental task to reveal trustworthy mechanisms. Without a mechanistic understanding, extrapolations of current or recent-past trends in phenology into a warmer future are not warranted. The internal controls of plant phenology have evolved over millennia. They co-control biodiversity and ecosystem processes.

- Körner C (2006) Significance of temperature in plant life. In: Morison & Morecroft: Plant growth and climate change. Blackwell p. 48-69; Körner C, Bader D (2010) Science 327:1461-1462.

O2 – Photoperiod sensitivity of spring bud burst in temperate forest trees

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Warmer spring temperatures, as caused by climate warming, led to an earlier spring bud burst and an extended growing season in many temperate and boreal species. To which extent will the phenology of these species keep tracking rising temperatures in future? Temperature, photoperiod and degree of winter chilling are the main environmental factors controlling tree spring phenology. Contrary to the high inter-annual variation of spring temperatures, photoperiod is an astronomical, weather independent environmental cue for the progression of the season. Photoperiodic control of spring development prevents trees from flushing too early under mild winter and early spring temperatures, before the period of potentially fatal freezing damage is over. Photoperiod sensitive species are therefore likely to stop tracking climate warming the closer temperature modulated bud break is shifted toward the genetically fixed photoperiod threshold. We assessed the photoperiod sensitivity of spring bud break in several common temperate tree species using growth chamber experiments with variable photoperiod x temperature interaction. Short photoperiods delayed bud burst in late successional species to various degrees, whereas no distinct photoperiod sensitivity of bud burst was observed in early successional and exotic (ornamental) species, which are thus mostly temperature controlled. Climate warming will thus not necessarily lead to progressively longer growing seasons in late successional species, as is often assumed.

O3 – Evidence suggests limitations of experimental warming in comparison to spatial temperature gradient transplantations

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Simulating climate warming as well as reciprocal transplantation are powerful tools for predicting plant response to climate change. Both methods are widely applied to study community, species, or provenance response to climate warming. However, we detected limitations of experimental warming in comparison to warming by transplantation. Here, we investigated shifts in plant performance (phenology and increment) and linear dependencies on the temperature sum over the experiment time period for two different warming treatments, i.e. experimental warming (IR-radiation in combination with passive warming) and transplantation to a warmer site. In a full factorial design, the plants were furthermore exposed to an extreme drought, which lasted for 64 days (May-July 2010), to examine the influence of the different warming techniques under drought. The date of bud break of *Fagus sylvatica* (beech) seedlings (seven different provenances) and the height increment was measured. We found significantly differing shifts in phenology between both warming methods in comparison to reference conditions. The transplanted plants had a mean delay of three days of reaching the bud break in comparison to the experimental warming despite comparable temperature conditions. Furthermore significant differences between both warming treatments could be detected on height increment. Surprisingly under drought conditions the experimental warming had no negative effects on height increment of the seedlings, while the transplanted plants decreased by 32% under drought. A linear dependence on both parameters with magnitude of warming was not found. The results emphasize the need to acknowledge more aspects than just temperature when considering ecological response to climate warming. Our examination shows the complexity of simulating global warming, as required for accurate prediction of shifts in plant performance. Experimental warming methods have to be extended by further climatic parameters.

O4 – The discrepancy between understory and canopy spring phenology in temperate forest trees arises largely from ontogenic factors

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Although differences in the physiology and morphology of leaves between juvenile tree stages and mature deciduous trees have received a lot of attention, very few studies focused on their differences in leaf phenology. Understory tree species are known to exhibit earlier bud burst in spring than con-specific mature trees, allowing them to profit from sunlight before canopy closure. However, it remained unclear whether this asynchrony results from microclimatic differences between the ground level and the canopy level or if it reflects ontogenic effects. Here we explore this question by exposing seedlings of five deciduous tree species either within the understory or at canopy level (~35 m height) using the tower of a 45 m construction crane in a forest located in NW Switzerland. Leaf development of these seedlings as well as conspecific adults was monitored twice a week in spring 2012. Leaf emergence occurred substantially earlier in both seedlings grown at ground and canopy level than in con-specific adults, irrespective of species (a range from 7 to 40 days earlier, for *Tilia platyphyllos* and *Acer pseudoplatanus* respectively). In addition, seedlings grown at ground exhibited earlier leaf emergence than those grown at canopy height, from 3 to 9 days depending on species. The vertical temperature profile in forests can not explain the discrepancy in flushing dates between understory and overstory trees. This difference arises largely from ontogenic effects. Since juvenile trees exhibit contrasting phenological sensitivities to environmental cues than mature trees, the results underline that predictions of forest phenological responses to climate change appear challenging when based on seedling or sapling observations, such as in most experimental studies.

O5 – Ecology of Scale - Phenological observations with non-scientists

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Climate change induces shifts in plant phenological dates and affects biogeochemical process. Both however are subject to a substantial year-to-year variation and hence long-term trends are often not easily detected in short-term studies. However, phenology has the potential to rise awareness of climate variability and change among people outside the scientific community. To explore the possibility to bridge between scientific research and outreach in secondary grade school the scholars observe phenological developments of selected plant species (namely trees) that grow in their schoolyard or in its neighborhood. Besides direct visual observations low-cost digital time lapse cameras are used, and

the green fraction of regions of interest in a time series of images is analyzed in the computer laboratory.
The technology of time lapse cameras and easy-to-use software to analyze images has become affordable and usable by non-scientists. This helps the better understanding of phenological processes: interested individuals can contribute their phenological observations via the so-called Citizen Science approach. Our presentation will provide an overview over experience gained so far in bridging between science and school education in a pilot project of the Competence Center Environment and Sustainability (CCES) of ETH Zürich and GLOBE (Global Learning and Observations to Benefit the Environment), and the Citizen Science projects PhaenoNet and Open the Book of Nature.
If it is possible to obtain a large number of phenological observations of sufficient quality to be useful for science from interested persons, a great improvement of our knowledge on spatial variability of phenological developments could be achieved. This may lead to an "ecology of scale" (analogous to economy of scale) where the large number of observations would be key to advance our understanding of the links between climate change and phenology.

P1 – Global change effects on different provenances of *Fagus sylvatica*: combining laboratory and field experiments

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Climate change as predicted for Central Europe will be associated with a change in precipitation patterns. While the impact of reduced precipitation has been quite intensively studied for several grassland communities, not much is known yet about effects on the understorey vegetation of temperate forests. We studied drought effects on 1 yr-old saplings of *Fagus sylvatica* from three different provenances from north-east to south-west Germany and hypothesized that drought tolerance is related to climate conditions at the population's origins. Plant individuals were grown in tubes of 1m length and 15cm diameter in the greenhouse. The experimental setting allowed to adjust the water content in different depths of the tube. On two harvest dates, we examined above- and belowground growth and in addition recorded different physiological and anatomical characteristics, such as transpiration, photosynthesis, leaf water potential and leaf osmotic potential. The responses were related to field measurements carried out in the roof experiment in the German Biodiversity Exploratories (BE-DRY).

Session 17 – Extending Biodiversity Ecosystem Functioning research towards Ecosystem Services

Chairs: Helge Bruelheide, Helmut Hillebrand, Sabine Both

O1 – Decomposer diversity and identity influence plant diversity effects on ecosystem functioning

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Plant productivity and other ecosystem functions often increase with plant diversity at a local scale. Alongside various plant-centred explanations for this pattern, there is accumulating evidence that multi-trophic interactions shape this relationship. Here, we investigate for the first time if plant diversity effects on ecosystem functioning are mediated or driven by decomposer animal diversity and identity using a double-diversity microcosm experiment. We show that many ecosystem processes and ecosystem multifunctionality (herbaceous shoot biomass production, litter removal and N uptake)were affected by both plant and decomposer diversity, with ecosystem process rates often being maximal at intermediate to high plant and decomposer diversity and minimal at both low plant and decomposer diversity. Decomposers relaxed interspecific plant competition by enlarging chemical (increased N uptake and surface litter decomposition) and spatial (increasing deep root biomass) habitat space and by promoting plant complementarity. Anecic earthworms and isopods functioned as key decomposers; although decomposer diversity effects did not solely rely on these two decomposer species, positive plant net biodiversity and complementarity effects only occurred in the absence of isopods and the presence of anecic earthworms. Using a structural equation model, we explained 76% of the variance in plant complementarity, identified direct and indirect effect paths and showed that the presence of key decomposers accounted for approximately three-quarters of the explained variance. We conclude that decomposer animals have been underappreciated as contributing agents of plant diversity–ecosystem functioning relationships. Elevated decomposer performance at high plant diversity found in previous experiments likely positively feeds back to plant performance, thus contributing to the positive relationship between plant diversity and ecosystem functioning.

O2 – Patterns of soil fungal communities in subtropical Chinese forests in relation to plant diversity

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Soil fungi are important components of the soil microbial communities playing a key role in terrestrial ecosystems. They facilitate decomposition of organic matter and nutrient recycling. On the other hand

as symbiontic partners of plants, they enhance nutrient uptake of most of the higher plants thereby improving plant growth and productivity. Though a number of studies reported the importance of fungi in the subtropical forest ecosystem, the role of plant diversity on the diversity and fungal community composition is still lacking.
Thus we want to know about the potential and active fungal community in subtropical forest soil samples. Especially, we want to find out how tree diversity and tree species identity affect the soil fungal community.
Thus within the frame of the world´s largest forest biodiversity experiment “BEF China” (www.bef-china.de/), we are investigating the fungal diversity and community across five plant diversity gradients (1, 2, 4, 8, and 16 plant species). The study site belongs to the Random Extinction Scenario main experimental plots of the BEF China. This special design will enable us to disentangle the effect of plant diversity and the neighboring tree species effect on the soil fungal community. Soil samples were collected in Oct 2011, DNA and RNA were extracted and both the potential and active fungal metagenomes will be assessed using a massively tagged and parallel pyrosequencing approach. The fungal ITS rDNA amplicon libraries will be sequenced using the 454 GS FLX+ sequencing system and the sequence data will be analyzed with a number of soil and plant related explanatory variables. We planned to analyze a total of 24 tree species planted in 5 diversity levels and in this presentation the first subset of the soil fungal community associated with 8 tree species at four diversity levels will be presented.

O3 – Does woody plant diversity and successional stage influence macrofaunal saprophagous? A case study in a diverse forest ecosystem in south-east China

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The relationship between species diversity and ecosystem functions is one of the main interests of ecological research today. Increased woody plant species diversity is supposed to result in numerous functions (e.g. greater herbivore diversity, especially in the highly species-rich subtropics). Although decomposition is a key function in ecosystems, the effect of woody plant diversity on saprophagous diversity in subtropical forests is still poorly known. For our study we chose macrofaunal decomposers because they are known to have the potential for a tremendous effect not only on decomposition but also on soil development.
Within the framework of BEF (biodiversity–ecosystem functioning) China we conducted our investigation in 27 comparative study plots (CSPs) in the Gutianshan National Nature Reserve, Zheijang Province, South-East China. Plots represent different woody species richness (25 – 69 trees and shrubs per plot) and a successional gradient of forest stand age.
Macrofaunal species were caught with pitfall traps from March to September 2009. Data analysis was done with a linear mixed-effect model including environmental predictors. Predictors were eliminated in a stepwise procedure, when their exclusion improved the model. Tree species diversity as the remaining predictor turned out to be significant. The mean species richness of decomposers increases with woody plant species richness. For the successional stage no effect could be detected. Our results indicate that woody plant species diversity in the hyperdiverse subtropical forest ecosystem has a clear impact on the diversity of saprophagous macrofauna.

O4 – Effects of tree species and functional diversity on the resistance against insect herbivores

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A major challenge in forest research is to assess the functional significance of biodiversity for ecosystem functioning. Whereas identity-effects of single tree species on certain ecological processes are well known, knowledge about the biodiversity ecosystem functioning (BEF) relationship is still scarce.
Observational and comparative studies have been vital in describing correlations between biodiversity and ecosystem processes across existing forest stands, but are criticized due to the potential of co-varying factors to confound interpretations and for their limited ability to isolate cause and effect in the BEF relationship. The tree diversity experiment BIOTREE serves as a complementary approach to assess the functional importance of different elements of tree diversity (tree species, functional diversity) and to further explore underlying mechanisms while keeping confounding factors constant.
Over two years, we investigated resistance to pest insects, an important ecosystem function that has received limited attention in forest biodiversity studies so far. This was done for different herbivore guilds at two of the BIOTREE sites, along gradients of tree species and functional diversity, testing the hypothesis that more diverse forests are more resistant to pest insects. Preliminary analyses revealed that pure stands suffer more damage by leaf miners and sap feeders than mixed stands in 2010, whereas the opposite was true for skeletonisers, leaf rollers and chewers. However, damage patterns along the diversity gradient varied across host species, with e.g. *Fagus sylvatica* (L.) and *Pseudotsuga menziesii* (Mirb.) Franco showing less sap feeding damage at higher tree diversity while the reverse was observed for *Picea abies* (L.) H. Karst.. Carefully assembled forests stands may therefore improve insect pest control by e.g. reducing the concentration of host trees or by providing a more diverse habitat thereby improving the top down control by natural enemies.

O5 – Diversity, abundance and host specificity of dead wood inhabiting saproxylic beetles

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Saproxylic beetles form an essential part of the forest ecosystem as decomposers of dead wood, predators and vectors for wood-decaying fungi. In intensive forestry dead wood is often completely removed from forests. As a consequence, many saproxylic beetle species are threatened and appear on Red lists. Numerous studies prove the need of retaining dead wood stems in forests for the maintenance of a rich saproxylic beetle fauna, but knowledge about the quality of different tree species to serve as a suitable habitat for saproxylic beetles is scarce. Our main questions were: Are there differences in the diversity and abundance of saproxylic beetles in dead wood from different tree species? How host specific are different beetle species? Does the colonization of dead wood depend on the surrounding forest type (deciduous versus coniferous)? Our study was carried out in 21 forest plots of the Biodiversity Exploratories Hainich-Dün and Schwäbische Alb. Six of the plots were located in coniferous forest and 15 in deciduous forest. We used closed emergence traps, which were installed on lying dead wood stems of 13 tree species (4 coniferous, 9 deciduous) to sample all beetles hatching from the stem. On each plot two replicates of the 13 tree species were exposed, resulting in a total of 546 stems equipped with emergence traps. We sampled over 22000 individuals of saproxylic beetles from 162 species and 38 families. First results of our analysis will be presented at the meeting.

O6 – Plant diversity enhances the density and diversity of aboveground arthropods and the ecosystem processes they govern

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Plant species loss affects the abundance and diversity of above- and belowground arthropods, which have significant impacts on ecosystems. However, only few studies have so far linked plant diversity effects on arthropods to processes affected by these organisms within the ecosystem. Also the mechanisms underlying changes in the arthropod community and arthropod-related ecosystem processes remain unclear.

Here, we assessed how plant diversity affect the abundance and diversity of herbivores and decomposers, using an experimental plant diversity gradient ranging from monocultures to 60 species mixtures within a grassland biodiversity experiment (The Jena Experiment, Germany). Eight years after establishment of the experimental plots, arthropods were collected across an entire growing season using pitfall traps (decomposers) and suction samples (herbivores). Arthropod herbivory was measured in spring and summer, and decomposition rate of plant litter was quantified during a nine week litterbag experiment. We used structural equation modeling to investigate direct and indirect effects of plant diversity on the arthropod community and on herbivory and decomposition.

We identified direct positive effects of plant diversity on abundance and diversity of herbivore insects, leading to higher herbivory rate. Moreover, herbivory was increased by an indirect effect of plant diversity, mediated by higher aboveground productivity at higher plant diversity levels, leading to higher herbivore abundance and diversity. Similarly, decomposition increased with increasing plant diversity, through both direct and indirect effects. The indirect positive effect was mediated by higher plant aboveground biomass, leading to higher abundance and diversity of decomposing arthropods. Higher diversity of decomposers in turn enhanced decomposition. Our results show that plant diversity not only affects the composition of the arthropod community, but also ecosystem processes governed by them. This is important for the current discussion on the importance of biodiversity for ecosystem services where the relationship between increased biodiversity and increased function is often assumed rather than proven, in particular for groups other than plants.

O7 – Functional diversity-effects on transmission to foliar fungal pathogens in the German tree-diversity-experiment BIOTREE

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Foliar fungal pathogens are both part of forest biodiversity and driver of community dynamics, and thus, can impair forest stability and fitness of tree individuals and species. Tree functional diversity of a forest has been predicted to affect the spread of the pathogen, the diversity of diseases, and co-evolutionary processes. We hypothesized that 1) species number of foliar fungal pathogens and pathogen load per individual is negatively related to the functional diversity of host tree species, and 2) pathogen load depends on community composition and on the presence of particular disease-prone tree species. Pathogen diversity and load was determined on 14 deciduous and two conifer tree species of the nine year old BIOTREE-experiment in Bechstedt, Thuringia, Germany. Micro- and macroscopic assessment of pathogen load was performed by a complete qualitative and quantitative survey of all fungal pathogens present in a representative sample set of leaves or needles of each tree individual. Our results showed that tree functional diversity suppressed particular pathogenic fungus species and their pathogen load. In addition, we encountered strong tree species identity effects at the plot level, i.e. *Quercus petraea* contributed disproportionally to a high plot pathogen load. Thus, we showed that disease risk and pathogen transmission in forest tree species depends on tree functional diversity.Furthermore, plant species composition has to be taken into account to explain pathogen infections at the community level.

O8 – Tri-trophic interaction networks along a tree diversity gradient of BEF-China

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Multitrophic interactions involving producers and consumers are central elements of all ecosystems. In forests, higher plants are the dominant producers and insect herbivores the most important consumers. Besides visible consumption of plant tissue, more cryptic herbivory occurs through sap-sucking insects, particularly hemipterans. Some of these insects are involved in mutualistic associations with ants called trophobiosis. The ants collect honeydew, a sugary liquid produced by the sucking insects and provide protection against predators, parasitoids, and pathogens. Trophobiosis are common, especially in disturbed habitats. Nevertheless, it is still not known how multitrophic interactions are affected by tree species diversity and tree diversity loss.
We observed over 7000 trees in an early successional forest in South-East China. The field sites are part of the BEF-China ecosystem functioning experiment. Altogether, 408 interactions between plants, sucking insects, and ants could be recorded on 15 tree species from five families. Three species of oaks (*Quercus ssp.*) contributed to more than 55% of interactions, being by far the most preferred plants by sucking insects. Around 30 species of sucking insects were collected, most of them Aphididae. They were tended by 17 species of ants. *Polyrhachis dives* was the dominant ant species in the study site. It tended 60% of the interactions.

We are currently analyzing how tree species diversity affects the overall structure and specialization of the trophobiotic networks. This will help to predict the consequences of tree species loss for sap-sucking herbivores and plant fitness.

O9 – Species-specific responses community diversity in experimental communities of subtropical trees

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Inter- and intraspecific diversity can have profound effects on the performance and fitness of plant communities. However, evidence for subtropical forest ecosystems is missing. Moreover, we still face a great lack of knowledge concerning interaction effects between species and genetic diversity and the response of different species and genotypes within communities to different levels of species and genetic diversity.
To assess the effects of species and genetic diversity on newly establishing subtropical forests, a factorial experiment was set up within the framework of the 'BEF China' project in 2009 near Xingangshan, China. A total of 264 plant plots hosted either monocultures or one out of three four-species mixtures, which contained either of three levels of genetic diversity. By summer 2011 no overall response of plant communities to species or genetic diversity was found. However, species responded differently to variations in species and genetic diversity, whereby species diversity has a greater impact on differences among species than genetic diversity. Since species showed a difference in their response towards species diversity, the future community composition of a young regenerating forest may be dependent on its initial species richness.

O10 – Long term legacy of fertilization: reduced plant diversity in subalpine grasslands 70 years after phosphorus application

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In 1930 Werner Lüdi established 340 plots of 1m^2 at the Schynige Platte (1925m a.s.l., Switzerland) in a subalpine matgrass-dominated pasture on spodic cambisols. He fertilized the plots with different amounts and combinations of N, P, K, $CaCO_3$, Mg, and compost at varying durations until 1942 to increase yield in low productivity subalpine pastures. For analyses we calculated the total amount of each nutrient per plot over time. Today, his experiment represents a unique opportunity to study long-term effects of fertilization on grassland communities. In 2009 we recorded all vascular plant species and measured aboveground biomass of all plots and on 155 plots also bryophytes and lichens. We calculated mean Landolt indicator values per plot for nutrients (N) and pH (R) to indicate differences in plant community composition among treatments. In addition, we sampled soil, extracted exchangeable cations, measured soil surface and soil pH, C/N, and plant available $NaHCO_3$-extractable PO_4^{3-}. We analyzed data with linear models correcting for spatial autocorrelation. Surprisingly, 70 years after abandonment of fertilization, we still found lower plant diversity on plots fertilized with phosphorus. Plant diversity was also negatively related to Al^{3+} in soil, which is mobilized at pH values below 4.2, having toxic effects on most plant species. Soil PO_4^{3-}, mean N indicator value and aboveground biomass production were still positively related to P application. The addition of $CaCO_3$ still had positive effects on Ca^{2+} content in soil, which consequently increased soil surface pH, soil pH and mean R indicator value, and decreased plant available Al^{3+} in soil, whereas compost application had opposite effects on these variables. The increase of soil surface pH resulted in higher bryophyte diversity. The long-lasting effects of fertilization on biodiversity, nutrient cycling, and productivity indicate very inert resilience of subalpine grassland systems.

P1 – Linking biodiversity assessment of Miombo woodlands in Southeast Angola with the valuation of ESS

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In terms of ecosystem research the Southeast of Angola is often regarded as "terra incognita" due to decade long civil war. Today, this region is undergoing a rapid transformation due to remigration of the population and economic development resulting in an accelerating demand on land use. The “Future Okavango Project” aims to close the gap between the urgent need for natural resource management and the inexistence of adequate data by integrating baseline biodiversity research with transdisciplinary assessement of ecosystem services.
Vegetation mapping combined with an integrated approach of spatial species distribution modelling and remote sensing applications provide a catchment wide analysis of biodiversity and vegetation patterns. Results for the Miombo woodlands of the Rio Cuchi and Rio Cusseque catchment are presented. Furthermore we outline the way forward to integrate these results into an holistic assessment of ESS using ethnobotanical tools, scenario building and valuation of the delivery of ecosystem services.

P2 – Dare to be different - Plant functional trait variation in response to different plant diversity and resource availability

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In many recent ecological experiments, the essential role of biodiversity for ecosystem functioning could be stressed. Although plant functional traits are increasingly used to identify plant strategies and to explore the meaning of plant functional diversity, the importance of trait differences among species and trait variation within species for complementary resource use and thus co-existence in more diverse communities have not been sufficiently accounted for. In the underlying project, the variation of plant functional traits in reaction to differences in resource availability and increasing plant diversity and their impact on community performance (as biomass production) are investigated.
Firstly, the influence of 3 different levels of light intensity crossed with 3 different levels of nutrient availability on above- and belowground traits, as well as differences in resource allocation patterns was studied. Four perennial herbaceous (*Centaurea jacea, ssp. jacea, Knautia arvensis, Plantago lanceolata, Prunella vulgaris*) and four grass species (*Anthoxanthum odoratum, Arrhenatherum elatior, Dactylis glomerata, Lolium perenne*)native to grasslands were analyzed in their reactions to this manipulation in resource availability, in absence of competition, in a pot experiment. It can be shown that different intensities of both resources lead to species specific responses, depending on the analyzed trait.
Secondly, it is the aim of the project to assess the validity of niche complementarity and the importance of plant functional trait variation of the aforementioned species in combination with different plant diversity levels for species interactions and productivity by conducting a field experiment. Thus, effects of functional identity can be further investigated to aid the understanding of ecosystem processes and the importance of biodiversity in the context of a variation in resource availability.

P3 – Composition, distribution and abundance of vascular plant species in rice-based production systems

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The growing world population increases the already high land-use intensity. On sites of rice production and their surroundings this is likely to affect biodiversity resulting in a loss of important ecosystem functions and services. Effects of the global change might further worsen this situation. Therefore, an assessment of the biodiversity of vascular plant species in different rice production systems of Southeast Asia was started in March 2012. The present study focuses on the composition, distribution and abundance of vascular plant species occurring on the borders of paddies.
The inventories were made from March to July 2012 in seven regions of Vietnam and the Philippines. Altogether 70 paddies were observed, with five pairs of paddies per region. Each pair represents one diverse and one poorly structured environment. The vegetation on the borders of each paddy was sampled using a modified Braun-Blanquet scale. Additionally, soil samples of the borders were taken at each site. The surrounding habitat structures and paddies were sketched and recorded by way of relevé.

The taxonomic diversity, life form composition and abundance of the recorded plant species and the plant community composition are presented. Differences in plant species richness have been found between richly and poorly structured sites. Other factors like the diverse geographical and climatic conditions and the distinct agricultural, socio-economic and cultural practices are related to the differences in plant species richness between the regions. The diversity and impact of alien species are also quantified.

These are the first steps towards a complete inventory and assessment of the vegetation in the paddies and their surroundings. Phylogenetic data will also be evaluated. Functional plant traits will be used to specify the relations between the plants and ecosystem functions.

Session 18 – Forest Monitoring and Ecosystem/Ecophysiological Studies – Have Aims and Results ever been matched up?

Chairs: Walter Seidling, Matthias Dobbertin, Andreas Bolte

O1 – Tree defoliation assessments - limitations and advantages

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In the mid 1980s under the fear of acid rain and ‚Waldsterben' the assessment of tree crown condition, namely tree defoliation or crown transparency, became the main tool to assess the feared changes in forest vitality. The proportion of trees above a certain assessed defoliation level was reported as the proportion of damaged forest area. Although, it became soon obvious that crown defoliation was not a cause-specific indicator the praxis continues until today. However, the validity of visual crown assessment has frequently been questioned, either due to the uncertainty of the assessment or because of the unclear ecophysiological relevance of the assessed indicator.

In this review presentation, first, the different methodologies of crown defoliation or transparency estimations are briefly explained and the observed estimation uncertainty of visual transparency assessments is presented. Expected relations to tree growth and survival are outlined and possible causes of reduced or increased foliage summarized. Examples are given from correlative and experimental studies for either using tree defoliation as a response to environmental factors or treating tree defoliation as a cause for tree growth and mortality changes. Studies attempting to use the indicator in across country analysis or between species and geographic site evaluation are compared with species-specific studies and within forest stand comparisons.

Suggestions for the use of tree defoliation as indicator tree condition are given with regard to assessment training, sampling design and data evaluations. If appropriately used tree defoliation assessment can be used as an important additional indicator in forest ecological studies. As an indictor for the effect of air pollution tree defoliation assessment is, however, of limited value.

O2 – Forest monitoring and fundamental research complement one another - integrated evaluations on cause effect relationships in a sessile oak ecosystem

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The infrastructure of the research plot was established by Landesforsten Rhineland-Palatinate, long time monitoring is done by the FAWF, the forest research center of Landesforsten and fundamental research aspects are carried out by several institutes of cooperating universities from Rhineland-Palatinate.

Long time monitoring activities like assessment of deposition, soil solution, crown condition, mortality rate, growth, litter fall, immission of air pollutants started in 1985, fundamental research concerning physiological, entomological, soil-biodiversity (mycorrhiza, soil critters) investigations as well as sap-flow

or leaf gas exchange measurements or dendrochronology measurements are done periodically by the universities.
The monitoring plot is situated in an 200 year old sessile oak stand with beech understorey on a Triassic sandstone site in the Palatinate Forest.
The mean defoliation rate increased, approx. 20% of the trees died off. Acid and the nitrogen deposition rates exceed the critical loads considerably. The input/output balances are negative with magnesium and calcium and clearly positive with nitrogen.Significant stress was caused by caterpillars und fungi, the dying-off was associated with *Agrilus biguttatus* infestation.
After the present level of knowledge unfavourable soil-chemical conditions, connected with an insufficient nutrient availability are crucial as pre- disposing factors in the stress complex of this plot. High ozone concentrations and defoliation by caterpillars are decisive as triggering stress factors. Infestation by Agrilus biguttatus favoured by the accumulation of warm summers finally causes the death of the trees.
The findings underline the importance of comprehensive, complete and long-term assessments of all substantial abiotic and biotic stress parameters and of modelling water and bioelement balances as well as fundamental research to e.g. special questions or intensive investigations which could not be carried out by the staff of the forest research center.
With this kind of cooperation an optimal use of know how of different scientific disciplines and an cost-efficient benefit can be realized.

O3 – Changes in tree physiology during drought-induced tree mortality

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Global occurrences of forest dieback have been linked to drought and heat and this phenomenon is expected to increase with anticipated climatic change. Surprisingly, we do not have a thorough understanding of changes in tree physiology during drought-induced mortality and there still is an imminent need for more data, especially from studies that not only stress but actually kill trees. In a series of combined field- and greenhouse experiments, we are currently investigating responses in tree physiology with respect to water transport, carbon assimilation and allocation, carbon metabolism and storage use, and whole-tree carbon balance under treatments of induced lethal drought and carbon starvation. Treatments are carried out until tree death occurs and will provide data for broadening our understanding of tree physiology under lethal drought.
Experimental drought killed trees (young Norway spruce) within 3 months and caused a rapid decline in carbon assimilation. Although droughted trees maintained photosynthesis early in the morning and during mild cloudy days even during advanced drought, the sustained respirational demand soon forced trees into a negative carbon balance. Available carbon was deviated from growth to maintenance. Drought did not cause irreversible xylem cavitation but severe stem shrinkage which suggests that phloem functioning was reduced. This finding is further corroborated by an uncoupling of root from needle/branch bulk NSC $^{13}C\delta$. The$^{13}C\delta$ signature of root-respired CO_2 indicated the use of stored carbon early during drought and severe carbon limitation during advanced drought. Root tissue NSC concentrations were very low at the end of the experiment. However, NSC concentration in needles and branches did not decrease with drought but increased in above-ground tissues of trees exposed to drying-rewetting cycles. This increase may be interpreted as a change in carbon allocation to promote osmoregulation. Additional data from the greenhouse experiment may show whether the maintenance

of carbon pools in above-ground tissues was a purposed promotion of drought tolerance or resulted from impeded carbon translocation to sink tissues.

O4 – Can we link ecophysiological performance of beech to drought stress to provenences?

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European beech (*Fagus sylvatica* L.) is one of the most important broad-leaved trees in Europe. Their ecophysiological adaptedness and adaptability to climate variability and long-term climate change is very important for the growth performance. For a better understanding of the responses of beech to environmental changes the ecophysiological flexibility has to be linked to genetic differences between populations. Therefore, a provenence experiment was conducted by the Institute of Forest Genetics, von Thünen-Institute (vTI) in Schädtbek (Schleswig-Holstein). European beech seed material from six different autochthonous provenances in Europe representing in particular differences in annual rainfall were collected and cultivated under similar conditions. Saplings were planted in 1995 to test climate response of the trials under comparable environmental condition. Transpiration and photosynthesis were investigated in 2005 and 2006. There are significant differences between the six provenances with regard to photosynthesis performance, transpiration and the increment development. At least in the year 2005 after a drought period of several weeks, the three provenances originating from sites with low precipitaion are characterised by especially low leaf conductance and ETR-values. Leaf conductance as expression of stomata opening obviously influences the increment development. For all provenances, extreme dry periods like in summer 2003 caused in the following year a small stomata opening and therefore low biomass increment. Therefore, the sensitivity of some provenances against all kinds of stress appears higher in the following years after dryness than those of other provenances. Hence, in future an increased frequency and severity of drought events may contribute to a destabilization of forests build up by more sensitive provenances. Understanding of the variability of ecophysiological processes is important for its integration into long-term forest monitoring.

O5 – Comparative tree ring analyses of Douglas-fir, beech and spruce growing along a climate gradient in Central Europe

Andreas Rzepecki[1], Frank M. Thomas[1]

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Tree-ring formation is closely related to climate. Therefore, tree rings are commonly used as indicators of past climate conditions. Interspecific comparisons among tree-ring time series of various forest trees can also provide retrospective information on different responses of these species to weather extremes such as intense drought, and can help to predict future changes in growth and biomass production. Against the background of the current climate change, forestry is searching for tree species and species compositions that provide a high stability of the forest stands and allow for a sustainable use. To this end, even the use of non-native species, in particular of Douglas-fir (*Pseudotsuga menziesii* [Mirb.]

Franco), has to be considered because of its high growth rates, valuable wood and low sensitivity to pests (depending on the variety).

We analyzed tree ring growth (total width, late wood and early wood) of approximately 50-year-old Douglas-fir individuals and coeval trees of regional relevant forest tree species (either *Picea abies* or *Fagus sylvatica*) growing at the same site along a climate gradient in Central Europe. To reveal the influence of stand composition and species interaction each sampling site consists of a pure stand of Douglas-fir, a pure stand of the other relevant forest tree species and a mixed stand.

First results on the tree ring time series of the different species from southern Germany up to the Netherlands in comparison to site-specific climate data (mean temperature, precipitation) and the newly developed Standardized Precipitation Evapotranspiration Index SPEI (Vicente-Serrano et al. 2010) will be presented.

This project is being conducted within the framework of the EU-INTERREG IVB program ForeStClim (“Transnational Forestry Management Strategies in Response to Regional Climate Change Impacts”).

Keywords: tree ring analyses, drought index, growth increment

- Vicente-Serrano S.M., Beguería S., López-Moreno J.I., 2010. A Multiscalar Drought Index Sensitive to Global Warming: The Standardized Precipitation Evapotranspiration Index. Journal of Climate, 23, 1696-1718.

P1 – Simulation of natural reforestation after windthrow in NRW - subproject of the "Virtual Forest NRW"

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The “Virtual Forest” models real forest stands as virtual ecosystems and production sites and therefore serves as an innovative source of information and aid for planning and orientation in forestry. The main objective of the “Virtual forest” is to develop an IT-based information system to support the forestry industry in North -Rhine-Westphalia. This database contains a mathematical description of biological (e.g. heigt, crown diameter, DBH) and technical aspects of the real forest. It includes conventional monitoring data combined with data from novel remote sensing techniques.

The single tree-based stand simulator SILVA forms one part of the “Virtual Forest”, which allows prognoses on single tree and stand growth regarding different site conditions and management strategies. Natural forest regeneration on open or semi-open areas such as windthrows, however, is not included in the “Virtual Forest” so far. Since extreme events such as storms have been strongly increasing over the last 30 years, the question of how natural regeneration processes can be integrated into conventional forestry practices gains in importance for the forest industry. Beyond that, the restoration of natural forest biotopes with a natural species and functional diversity (biodiversity) is a main goal of nature conservation. In order to simulate the site specific forest regeneration on open sites, the GraS-Model (Grassland Succession Model) is refined to model wood regeneration after windthrow.

P2 – Linking temperature records from weather stations to forest microclimate in a biogeographical context

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Most plant physiological processes act on geographical scales of meters or less and on temporal scales of minutes or less. Yet, most studies relating species distribution to climate used typical resolutions of kilometers and months at best. Commonly available climate records from weather stations or freely available coarse-resolution geographic climatic layers thus, do not reflect local climatic conditions. The deviation between meteorological data and on-site conditions were shown to potentially exceed the extent of the worst projections of climate warming. In this study we compared temperature measured on forest trees *in situ* with the closest weather station data (corrected for elevation). We selected sites where eight temperate deciduous tree species are growing at their high elevation cold limits in the Swiss Alps (from 1165 m a.s.l to 1804 m a.s.l.) and at their latitudinal cold limits in Sweden (from 58°18' N to 59°27' N) and recorded temperatures for two years (air temperature in the understory, 2-m above ground, in the top of tree canopies and -10 cm soil temperatures). In mountain terrain, scaling from weather station data to on-site forest conditions requires month-specific lapse rates of temperatures, separated for means and extremes (e.g. minima).However, residual contrasts after best scaling procedures from weather stations to in situ conditions reached 4 K (e.g. in one example the monthly absolute minima in October). At the time when 2-m air temperature reached its absolute monthly minimum (within the leaf-less deciduous forest in winter), temperature in the top of the tree canopy was found 1.7 K colder (the understorey was 1.1 K colder). These systematic deviations of low temperature extremes from those predicted from weather stations close the gap between geographical range limits of species, their physiological limits (e.g. freezing resistance) and meteorological information. The "thermal niche" concept of species range limits needs to account for such deviations of life conditions from meteorological data, should the niche boundaries have a functional meaning rooted in plant biology.

Session 19 – Functional plant ecology

Chairs: Guenter Hoch, Juergen Kreyling

O1 – Weather or weathering? Growth of *Nothofagus dombeyi* in a long-term chronosequence of volcanic soils in South-Central Chile

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At the western slopes of the Andes of South-Central Chile, Nothofagus forests constitute the climax of the primary succession on lava-based soils. In the Conguillío National Park, adjacent stands of N. dombeyi grow under the same climatic conditions, but on soils of completely different age. Hence, that location provides excellent opportunities to test the hypothesis that the growth of the trees is lowest on relatively young soils with low amounts of plant-available mineral nitrogen (N) and phosphorus (P), and better on older soils where weathering and the accumulation of organic matter have resulted in higher amounts of plant-available N and P. At five sites of different soil age (from Miocene to 3,500 years old), we sampled tree increment cores from six N. dombeyi trees each. In addition to the annual increment, δ13C ratios were determined in selected tree rings to test for differences in the trees' sensitivity to drought periods that can occur in summer. Contrary to our hypothesis, we found no significant differences in the annual diameter increment among the sites of contrasting soil age, despite of considerable differences in the concentrations of plant-available N and P in the soil. The lack of differences in the annual diameter increments allowed for establishing a "master chronology" that consisted of the pooled tree-ring chronologies of all investigated stands. From comparisons with climate data, we conclude that there is a distinct weather effect on the growth increment: small increments were found for those years in which at least one month with exceptionally high temperature and low precipitation occurred during the spring and summer (November through January) of Central Chile, whereas a high diameter increment usually was accompanied by at least one month with exceptionally high precipitation and low temperature during that three-month period. A significantly negative correlation was also found between precipitation and the δ13C ratios of the selected tree rings. Thus, the growth increment of the climax species Nothofagus dombeyi obviously is more closely related to the weather conditions or water relations of the sites than to the edaphic conditions of the soils that differ in age and in the extent of weathering. Keywords: climate, growth increment, soil age, stable isotope ratio, tree-ring analysis

O2 – Patterns in isotopic signatures of leaf and phloem water soluble compounds in adult forest tree crowns over space and time

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Signatures of the stable isotopes 13C and 18O are a useful tool to address plant ecophysiological activity. Water soluble leaf and phloem compounds are representative of recent assimilation products. In tree crowns, the spatial isotopic distribution is crucially influenced by the varying light environment. However, the temporal resolution of the isotopic signatures in natural abundance is not entirely enlightened to date and may reach from hours to days. In a time series of 6h intervals, twig samples of adult beech and Douglas-fir trees have been taken in three different crown heights on three consecutive sunny days in August 2011. The water soluble leaf and twig phloem compounds have been analysed on their signatures of stable carbon and oxygen isotopes. The physiological activity in the different crown heights of the investigated trees was monitored by means of porometry and sapflow measurements. Additionally, the decisive environmental factors irradiance, temperature and air humidity have been recorded along the vertical crown gradient. The evaporative demand varied strongly between the investigated days and caused distinct stomatal responses. There were slight variations in the isotopic signatures over the investigated time period. The vertical gradient was more pronounced in the beech than in the Douglas-fir. The variations over time and space were closely related between leaf and phloem water soluble compounds. The results make a contribution to the understanding of the turnover period of water soluble leaf compounds and give evidence about expedient physiological interpretation of their isotopic signature. Keywords: δ13C, δ18O, Fagus sylvatica, Pseudotsuga menziesii, crown gradient

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O3 – Wood anatomy and tree height as traits controlling hydraulic efficiency, vulnerability and productivity of tropical trees

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Under the prospect of more frequent and intense droughts as predicted for parts of South-East Asia and South America, a better understanding of the drought sensitivity of tropical trees is crucial. Increasing drought frequency may increase tree mortality, change tree species composition and reduce overall productivity. Tree mortality is expected to increase, especially among tall tropical trees, but the mechanisms leading to drought-induced mortality are far from being resolved.
Tree size and wood density are traits that are assumed to play a central role in drought sensitivity, but are also related to productivity and water consumption. With this study we present a dataset covering more than 400 tree individuals from 136 tree species from South-East Asia (Central Sulawesi, Indonesia) and South-America (South Ecuador) on sap flow, hydraulic conductivity (limited dataset) and wood anatomical traits in relation to tree size, wood density and stem increment and standing biomass. We

found all parameters regarding water consumption to be closely positively related to tree size, but wood density only negatively with stem increment and hence to be unrelated to hydraulic properties of the xylem in tropical angiosperm trees. A high hydraulic conductance as a prerequisite of high production is mainly achieved by more and larger vessels, and increasing vessel size is related to a higher risk of drought-induced embolism.
We conclude that hydraulic properties of tropical trees are unrelated to their wood specific gravity, but closely to tree size, and that tree size is a better indicator for vessel anatomical traits and hence hydraulic conductivity. Further, hydraulic conductivity and productivity are closely related. Tall tropical trees, which suffer most under prolonged drought periods, are exposed to a higher vapor pressure deficit compared to the understory and possess a much larger foliar biomass, and both demands for a highly efficient hydraulic system, mainly achieved by larger xylem vessels, which carry a higher risk of drought-induced embolism. Altogether, we hypothesize that tropical trees drought-susceptibility can be predicted from the easily measurable parameters tree height and stem wood anatomy.

O4 – Persistence of Mediterranean and autochtonous *Pinus sylvestris* seedlings in the Central Alps under climate change?

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Increased summer drought will exacerbate the regeneration of many tree species at their lower latitudinal and altitudinal distribution limits. In the European Central Alps, introduction of more drought-tolerant provenances or species is currently considered to accelerate tree species migration and facilitate forest persistence at the forest-steppe ecotone. In two common garden experiments, we tested the performance of *Pinus sylvestris* from the continental Central Alps under extended summer drought, and compared phenotypic plasticity of 6-months old seedlings and 3-year old saplings to that of *P. sylvestris* from a Mediterranean seed source at the southernmost distribution limit of the species in Europe. Relative distance plasticity index (RDPI) was used to calculate phenotypic plasticity in biomass allocation between provenances.
In the Central Alpine provenance, a 20% reduction in long-term summer precipitation resulted in a 50% reduction of seedling survival 6 months after seedling emergence. At the same time, higher emergence and lower mortality resulted in twice as many Mediterranean than Central Alpine seedlings present under dry conditions. By contrast, Mediterranean seedlings and saplings exhibited lower phenotypic plasticity in terms of biomass allocation, which led to higher investments into roots irrespective of water conditions. As a result, Mediterranean saplings were two times smaller and had four times lower aboveground biomass than Central Alpine saplings both under wet and dry conditions. In the longer term, limited aboveground growth capacity is likely to compromise the competitive ability of Mediterranean *P. sylvestris* provenances in Central Alpine forests since competition for light and nutrients from understory vegetation is substantial in temperate forests during seedling establishment. Even though the Mediterranean provenance showed higher emergence and lower mortality during early stages of tree regeneration under dry conditions, its low growth plasticity during the sapling stage questions the benefit of assisted colonization of Mediterranean provenances to facilitate forest persistence at the Central Alpine forest-steppe ecotone.

O5 – Growth dynamics and carbon relations of European broadleaved tree species at the elevational limit

Armando Lenz[1], Günter Hoch[1], Yann Vitasse[1], Christian Körner[1]

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Low temperature is the single most important factor that can exert the known overarching trends in species distribution of major European broadleaved tree taxa along latitudinal and elevational gradients. Apart from low temperature extremes, growing season mean temperatures could be too low for above and belowground completion of growth of trees at the species specific cold climate limit, as it is the case at the alpine treeline. In a current project we are assessing the performance of broadleaved tree species *in situ* along elevational gradients, to disentangle the effects of low temperature extremes and low temperature means on secondary growth. In autumn 2010 and in autumn 2011, tree cores of 8 different broadleaved tree species were collected along 3 elevational gradients always reaching the species specific climatic limit in the Western Swiss Alps. The cores of a total of 421 trees were used for growth-ring analysis as well as for the analysis of non structural carbohydrate concentrations in the outer sapwood. First results suggest no indication of growth limitation of trees at their species specific elevational limit over the past ca. 50 years, except maybe for *Fagus sylvatica*. In contrast, most species seem to grow very well at their respective elevational limit, with mean tree ring widths of more than 0.5 mm in all investigated species and maximum ringwidths at the elevational limit ranging from 1.1 mm for *F. sylvatica* up to 5.5 mm for *Fraxinus excelsior*. Interestingly, the frequency of negative event years – i.e. very narrow tree ring widths – increases with increasing elevation for most species (*Acer, Fraxinus, Fagus* and *Laburnum*), possibly reflecting effects of late spring frost events. Further, carbon relations at the species specific elevational limits will be deduced by the analysis of sapwood concentrations of non structural carbohydrates. We conclude that broadleaved tree species are not growth limited at the current elevational distribution limit. However, the cumulative frequency of negative event years with increasing elevation might hint at increasingly negative impacts by freezing events with elevation.

O6 – Temperate broad-leaved tree species survive two consecutive seasons at simulated treeline conditions

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Most European broad-leaved tree species reach their high elevation limit below the alpine treeline, but the physiological mechanisms behind the species-specific, cold distribution limits of temperate trees are largely unknown. Recent evidence indicated that the low temperature threshold for meristematic growth per se is similar among tree species. Hence, a direct cold-limitation of growth seems to insufficiently explain the different elevational distribution limits. Within a phytotron-experiment we tested whether saplings of 10 broad-leaved tree species can survive for two consecutive seasons at thermal conditions typical for the Swiss alpine treeline. The species under scrutiny differed largely in their natural upper distribution limits, ranging from *Carpinus betulus* (natural limit ca. 7 K below treeline) to *Sorbus aucuparia* (natural limit at treeline). The applied growing season conditions reflected mean temperatures, but lacked frost events during the season. The treatment consisted of two 20 weeks growing seasons with a seasonal mean temperature of 6 °C, separated by a short and mild

'winter' season with moderate nigh-time frosts. Control trees were treated with 6 K warmer growing season temperatures, but the same 'winter' conditions as in the cold treatment. Except for *C. betulus*, all species survived the two seasons at treeline conditions, but bud break, leaf development and winter-bud development was considerably delayed in several species. Compared to the warm controls, growth was severely restricted in the cold treated saplings. Our first results show a decrease of height and stem diameter increment in cold treated saplings by ca. 30 % in the most cold-adapted species (*S. aucuparia*), while the cold treatment reduced height and diameter growth by more than 90 % in the most cold-sensitive of the surviving species (*Fraxinus excelsior and Quercus petraea*). Overall, we could demonstrate that broad-leaved tree species can survive markedly colder and shorter growing seasons than present at their natural distribution limits. However, the delayed and incomplete development of buds towards the end of the season in most of the species indicate that they would likely not persist more severe winter conditions or late frosts during the growing season.

O7 – Continental intraspecific variance exceeds local interspecific variance in the response of grassland species to midwinter thaw events

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The role of diversity within versus among plant species in the response of plants to climate change has not yet been explored adequately. Here, frost following midwinter thaw events, which are expected to increase in frequency and duration due to climate change, was used as a climatic stressor to explore variation within and among species responses.

Twelve ecotypes of *Arrhenatherum elatius* from 4 European countries and 7 grassland species (grasses, herbs, leguminous herbs) from one German location were grown from seed and acclimated to winter temperature (-3°C) and light period in a growth chamber. In February, plants were thawed for 2 days or 6 days at 10°C, or subjected to control conditions, before being frozen to -10°C at 2°C/h, lasting 23 h in total. Direct root damage was assessed via plant ability to take up ^{15}N tracer. A second set of replicates for all treatments was transferred to a greenhouse and grown at 10-15°C for three weeks. Development of cover and greenness over time were quantified by digital pictures. Aboveground (live and dead) and belowground biomass was measured.

The variation in greenness and live above ground biomass were more than two-fold greater within species compared to among species. There was an interaction between within-species (ecotypic) and among-species biomass and greenness responses, which was explained by higher frost sensitivity within *A. elatius* ecotypes than among species. Overall, compared with the control, the 2 day and 6 day thaw periods reduced live aboveground biomass by 17% and 59%, and increased dead biomass by 20% and 180% respectively.

The results indicate that variation within a single plant species can be greater than variation among different plant species growing in one environment. This intraspecific variation should be considered in attempts to model the responses of species to climate change. The data further imply that increased variability in winter temperature conditions can result in considerably higher frost damage as plants lose frost hardiness during short warming phases.

O8 – Phenotypic response of annual plants to rain manipulation along a climate gradient and its implications for adaptation to climate change

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Plant species that can not tolerate climate change are under the risk of extinction. Annual plants are capable of an immense plasticity, allowing them to deal with varying environments. In this study we aim to characterise phenotypic variation in response to changed precipitation. Climate change effects were simulated in a unique long-term rain manipulation experiment which was conducted in a semi-arid and a Mediterranean site in Israel. In the 9th year after starting the manipulation we studied the response 16 abundant annual plant species to the different precipitation levels in situ. We measured life history traits such as growth and phenology along the growing season. The main goal was to find out which strategy plants use to respond to the rain manipulations. Typically a short growing season due to less precipitation affords a faster development to reach to reproductive success. Previous studies found that this trend is related to a decreased growth, which is contradicted by our own findings within the rain manipulation treatments. Our results show an increasing speed in development only in 5 species and it was connected to faster growth in all cases. In most species we found the opposite effect of a delayed onset of flowering due to delayed growth. A two-generations experiment was conducted to unveil the role of genetic adaptation versus plasticity.

O9 – Plant trait responses to environmental conditions and effects on ecosystem properties

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A combined analysis of plant trait responses to the environment, and their effects on ecosystem properties has recently been proposed. In this study, we related the trait composition of plant communities to soil nutrients and disturbance as environmental drivers and to productivity, decomposition and soil carbon as ecosystem properties. We surveyed two sites, one comprising intensively grazed and fertilized grasslands, the other consisting of heathland. Species abundance and trait values of 49 species were recorded in 69 plots, as well as soil resources, land-use disturbances, and ecosystem properties. Our main goal was to test whether the average or the diversity of the trait values of the vegetation had stronger effects on ecosystem properties. Structural equation modelling was used to perform a simultaneous analysis of trait responses and effects. Specific leaf area and leaf nutrient contents were always negatively correlated with stem dry matter content and canopy height, indicating greater investments in supportive and nutrient-conserving tissue as plants increased in size. In the agricultural site, disturbance was the single most important factor decreasing plant height, while leaf traits such as specific leaf area and leaf nutrient contents increased with soil resources in heathlands. Productivity was driven by leaf traits, and investments in structural tissue increased standing biomass and soil carbon. Different environmental drivers in the two sites produced opposing leaf trait effects on litter decomposition. Ecosystem properties were explained by the community mean trait value, rather than by functional diversity. We conclude that changes in community composition and dominance hierarchies deserve the most attention when ecosystem properties must be maintained.

O10 – Plant trait responses to the environment and effects on ecosystem properties in salt marshes

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The assignment of different traits to ecosystem properties and to the species which express them most strongly contributes to the understanding of of loss of biodiversity, particularly against the background of global change and human induced habitat destruction. In our study, we explored the responses of morphological, chemical and allocation plant traits of salt marsh species on the community level to the environment and examined their effects on properties of the carbon cycle, i.e. aboveground biomass (AGB), ANPP (Above Net Primary Productivity), decomposition, and species richness as an indicator of biodiversity as ecosystem service.
We used path analysis to evaluate relationships between environmental parameters, functional traits and ecosystem properties and estimated total model fitness by structural equation modelling (SEM).
Keystone response and effect traits were belowground dry mass (BDM) responding to groundwater level and salinity, and leaf C:N ratio and specific leaf area (SLA) responding to inundation frequency. Inundation and salinity led to higher allocation in belowground biomass and adaptation to salt stress in leaves (low C:N ratio), which resulted in more rapid turn-over of resources by decomposition and facilitated species richness. Conversely, release from these strong abiotic controls resulted in accumulation of standing biomass, plant litter, and low species richness which was controlled by high leaf C:N ratios and aboveground allocation.Our study underlines the importance of multiple traits generating different response-effect relationships for maintaining carbon cycle properties and biodiversity.

O11 – What's a shrub? - Life history strategies of woody plants in South African savanna

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Savannas are defined by the co-existence of a continuous grass layer with scattered trees and shrubs. They are ecosystems of high ecological and economical importance, covering about 11 % of earth’s land surface and supporting the livelihood of about one-fifth of the world’s population. However savannas are unstable systems and a slight shift in environmental conditions can lead to a conversion of the ecosystem to forest or grassland. This makes savannas susceptible to changes in climate and land-use expected for the next decades. Several studies have shown that alterations in the ecological drivers fire, herbivores and resource availability change the size structure and dynamics of woody vegetation in savannas. A major issue is the invasion of shrubs in savanna ecosystems (bush encroachment). Yet a clear ecological distinction between tree and shrub, which might help to understand this process, is lacking for savannas. The question addressed here is: are shrubs “just small trees”, or do they represent a different, distinct ecological strategy?
Based on field studies in the Kruger National Park, South Africa, investigating 30 life-history-related traits on 25 of the most common woody plant species of this area, we characterize the growth forms tree and shrub as different life history strategies. We focus on traits related to plant architecture, leaf characteristics, photosynthesis and the resprouting capacity. In the ecological context of fire, herbivory

and resource use, these morphological and physiological traits can be interpreted to characterize at least two different life-history strategies: the shrub-growth form as avoidance and adaption strategy and the tree-growth form as escape and persistence strategy. The data also indicates a possible third life history-strategy, realized in medium-sized species particularly involved in bush encroachment. Species of this category show a distinct trait pattern different from trees and shrubs, respectively.
The given definitions are of theoretical and applied interest, as they a) might help to represent savanna vegetation more precisely in dynamic global vegetation models (DGVMs) and b) might help to improve management strategies related to current dynamics in savanna vegetation, as for example bush-encroachment.

P1 – Using THz-Time Domain Spectroscopy (THz-TDS) for non-invasive measurements of drought-stress response in conifers

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The determination of a plant's water status is a crucial step in measuring drought-stress response. Since scholander pressure chamber is an invasive method and chlorophyllfluourescence analyses are still critically debated as surrogate only, non-invasive and reliable alternatives are highly desired.
Here, we present a procedure that enables determining the relative leaf water content of plants with THz-TDS. The basic principle is that compared to non-polar organic cell compounds water serves as strong absorbent to THz radiation. In a case-study, silver fir seedlings (*Abies alba* Mill.) were exposed to drought stress and re-watered afterwards. We obtained evidence that both decreasing and increasing water content of the needle tissue was reliably displayed by the respective transmission curves.
The results encourage for using the method in manifold ways in plant ecology or ecophysiology, respectively. Furthermore, the procedure will support phenotyping a quantitative trait which later on can be associated to relevant genomic variation.

P2 – Tree seedling performance above treelines: towards a mechanistic understanding of treeline shifts with climate warming

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With climate change, Alpine treelines are expected to rise to higher altitudes. For a more mechanistic understanding of the anticipated treeline responses to climate warming, studies of how tree seedlings perform above current treelines are essential.
Therefore, we analyzed the performance of germinating seedlings of seven common mountain forest tree species at three sites above and below the current treeline, in an altitudinal transect near Davos in the eastern Swiss Alps. We followed the seedlings over four vegetation periods, and analyzed their survival, height growth, biomass, and biomass allocation (root-to-shoot ratio, foliar mass ratio) in relation to the environmental drivers soil temperature, light, nitrogen and water availability. Light availability was measured as percent radiation unobstructed by surrounding ground vegetation, and foliar stable isotopes of carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) were used as integrated measure of past water and nitrogen availability, respectively. Multiple linear regression analyses were used for a mechanistic interpretation of seedling performance differences among species and among sites.
Survival differed among species, but was higher than expected above the treeline, and not according to most species' current altitudinal ranges. Early survival was related to light availability, while later survival could not be linked to any of the measured environmental variables. Seedling growth and biomass allocation were strongly linked to species-specific $\delta^{15}N$-patterns and location, suggesting that nitrogen was a limiting factor in seedling performance. We conclude that soil nitrogen availability can override altitude-related climatic control of seedling performance, potentially influencing future treeline shifts. Furthermore, based on the differences among species found in our study, future treeline species composition may change in areas where seed input is not limiting.

P3 – Plant Polyphenols in Biodiversity Research - Different sampling and storage conditions and ecological interpretations

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We analyzed tannin and non-tannin phenolics contents of 20 subtropical tree species from East China with the aims to assess the impact of two different sample storage and processing methods and to relate them to other plant functional traits. We collected a set of leaf samples of 20 species from 10 different families in 2009 and stored them under dry conditions. The sampling was repeated in 2011 using an optimized sample processing protocol involving lyophylisation. Total phenolics and tannin

content were quantified by the Prussian Blue assay and the radial diffusion method, respectively, and compared among the two different methods of sample processing. We found that the impact of different sample storage and processing conditions on the content of total phenolics and tannin was less pronounced than expected from the suboptimal sample treatment. Variance components analysis revealed that a considerable amount of variance in the contents of secondary compounds was explained by the taxonomic levels of 'family' as well as 'genus'. Based on mixed-effects models, including the taxonomic levels as random factors, we showed that, in these secondary metabolites, the taxonomic conservation was more pronounced than in other traits from the leaf economics spectrum known for the investigated species. In conclusion, for ecological studies including species from a wide variety of families and genera, the adverse effects of suboptimal sample treatment were largely overridden by the variation brought about by phylogeny. Moreover, in a non-metric multi dimensional scaling (NMDS) analysis we found total phenolics and tannin content to be strongly collinear, but negatively correlated with leaf toughness, indicating a trade-off in investment for defense between chemical and mechanical strategies.

P4 – Flora and vegetation patterns and diversity in inland and littoral sand dunes of Iran

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We investigated the vegetation of sand dunes in the Iranian Central Desert (Dashte Kavir) and on the Caspian Sea coast in N Iran. Although these two regions belong to different bioclimatic regions with different species composition, they have properties of vegetation structure and functional traits in common.

Sandy habitats are generally known as species-poor and stress-prone due to the extreme environmental conditions such as wind erosion, water deficiency and lack of soil and nutrients. Among the adaptive features of dune plants is the C_4 photosynthesis pathway which is a common trait among plants exposed to drought, high temperature and extreme habitat conditions. In this study four vegetation types have been distinguished: psammophyte vegetation (e.g. *Stipagrostis* spp.,*Cyperus eremicus, Artemisia tscherviniana, Cakile maritima*); halophyte vegetation (e.g. *Salsola rosmarinus, Salicornia iranica*); vegetation of semi-wet sites (e.g. *Saccharum spontaneum, Imperata cylindrica*) and ruderal vegetation (e.g. *Salsola kali* aggr., *Cynodon dactylon, Paspalum distichum*). All of these habitats are dominated or associated with C_4 plants.

In total, 157 relevés were collected in the study areas and 135 species belonging to 28 families were recorded. Of these, 37 species (27%) represent C_4 plants. Plant functional traits, chorology and environmental data of C_4 species were compared with those of the associated C_3 plants. The vegetation types have been discussed regarding their C_4/C_3 ratio and in relation to the climate data and soil characters. The soil texture, salinity and water availability have an important effect on the pattern of vegetation.

P5 – Tricky traits - Outdoor characteristics and indoor constraints

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Plant functional traits have been widely studied because of their potential to predict ecosystem functions and probably ecosystem responses to global change. Traits like specific leaf area (SLA) and leaf nitrogen concentration as well as plant height and photosynthesis are relatively easy measurable under field conditions. On the other side, most knowledge about root traits, like specific root length (SRL), area (SRA) and root tissue density (RTD) and nitrogen concentration, or growth rates is gained from greenhouse experiments or monocultures.
We compared above and belowground functional plant traits of 6 grassland species from a semi-natural grassland site to plants grown in the greenhouse. Both groups were exposed to the same 2 fertilization and 2 cutting treatments in a full factorial experiment to test whether trait responses under field conditions are comparable to responses of greenhouse grown plants to the same factors.
SLA and leaf N (mass and area basis) were higher in greenhouse-grown plants for all species. Further, aboveground responses to fertilization and cutting differed significantly between the two growing conditions. SRL and SRA were lower and RTD and root N were higher in the field-grown plants. Root responses of greenhouse-grown plants were contrary to what we observed in the field: the grass species' showed a strong SRL and SRA response to cutting in the greenhouse and a stronger response to fertilization in the field. However, the root N concentration response to fertilization was stronger in greenhouse-grown plants.
In summary: morphological responses to fertilization were less pronounced in greenhouse-grown plants compared to field-grown plants, although an increase in N concentrations upon fertilization occurred under both conditions. Cutting responses, on the other hand, were more pronounced in the greenhouse.
Thus, extrapolation of indoor plant responses to outdoor conditions should be done only very carefully for these 'soft traits'.

P6 – Using a multi-trait approach to manipulate functional diversity in a biodiversity-ecosystem function experiment

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A frequent pattern emerging from studies on the relationship between plant functional diversity and ecosystem functioning is that productivity increases with diversity. However, the manipulation of functional group richness in biodiversity-ecosystem function experiments goes along with major disadvantages like the transformation of functional trait data into categories or the exclusion of functional differences that occur between organisms in the same group. A number of new measures of functional diversity have been introduced, but knowledge about their practicability in manipulating functional diversity in experimental set-ups is missing. Based on the Functional Diversity (FD) approach developed by Petchey and Gaston we calculated FD of every possible 8 plant species mixture from a pool of 20 naturally co-occurring plant species. For the calculation we used data of 9 functional plant traits indicative for competition and complementary resource use, and also incorporated data on the origin of our selected plant species in terms of being native or exotic. Along a gradient ranging from low to high FD we planted 40 of these 8 species mixtures in mesocosms and kept them under controlled conditions in a greenhouse. We found a significant positive linear correlation between FD and aboveground productivity suggesting functional complementarity within the communities. The community weighted mean (CWM) for each trait was calculated and the results indicate that nitrogen fixation played the most important role for community productivity. But also the dependency of plants on arbuscular mycorrhizal fungi (AMF) and the ratio of native to exotic plants species within the community seem to influence community productivity. Whether and to which extent this continuous trait based approach of manipulating functional diversity leads to a better control of the sampling effect that is inherent in traditional biodiversity-ecosystem function experiments is discussed.

Session 20 – Importance of spatial patterns and processes for coexistence in plant communities

Chairs: Thorsten Wiegand, Andreas Huth

O1 – Towards a unified spatial theory of biodiversity

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

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One of the major goals in ecology is to understand the processes and mechanisms which promote coexistence of different species. Classical theoretical ecology predicts that two species competing for the same resources cannot stably coexist, however, for reasons that are poorly understood, the number of competing species often exceeds the number of limiting resources substantially. We argue that progress in resolving the paradox of highly diverse communities requires a change in the way the problem is tackled. We capitalise the tremendous amount of information on spatial patterns which is buried in large census plots of tropical and temperate forests. Our assumption is that the spatial patterns capture essential and time-invariant structural attributes of undisturbed forests and thus allow for general statements about of the mechanism promoting coexistence. The basic idea of the SPATIODIVERSITY project is to analyse the highly complex spatial patterns and to develop individual-based and spatially-explicit forest simulation models to generate the same type of data so that the same patterns can be quantified in the same way in the field and in the models. We use two complementary approaches to confront models with data and identify the simplest (i.e., parsimonious) models that account simultaneously for all (spatial) patterns. First, we start with a spatially explicit neutral model that is enriched step-by-step with additional processes and mechanisms. Second, we start with a fully individual-based version of the existing process-based forest model FORMIND which is then simplified. In contrast to the common approach, we additionally evaluate the ability of the model to capture aspects of reality with the variety of spatial patterns that are quantified from the data of the forest plots. Using multiple patterns is a key of pattern-oriented modelling and a powerful strategy of model selection that overcomes the old problem that several substantially different models may explain the same pattern. The new spatial perspective and innovative computer modelling techniques will allow us to derive new ecological results and open up new horizons for understanding and conservation of biodiversity.

O2 – Summary of the findings of the SPATIODIVERSITY project

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The objective of this presentation is to give an overview of the results and achievements of the SPATIODIVERSITY project after 3 years. The general objective of this project is to advance our

understanding on the relative importance of processes and factors that govern the composition and dynamics of species-rich communities. The project comprises three major tasks. First we quantify the information on spatial patterns which is buried in the fully mapped mega-plots of tropical and temperate forests, second, we use individual based models to deal with the highly complex spatial phenomena in an explicit way, and finally, we use pattern-oriented modelling to decode the information that is encapsulated in the spatial patterns. One mayor achievement of spatial pattern analysis is posing of the “dilution hypothesis” which states that stochastic dilution effects due to increasing species richness overpower signals of deterministic species associations. This suggests that, in the limit of very species rich communities, the spatial location of different species is in good approximation independent of each other. This is in sharp contrast to a long tradition that outlines the importance of species interactions. We have developed new methods for inverse parameterization of individual-based forest simulation models and are applying them to the BCI and the Sinharaja plot. We show how information theoretic approaches of statistical inference known from statistical modelling can also be applied to complex individual-based simulation models. For model parameterization we compiled a species trait data base for the BCI and the Sri Lanka plot and are applying rigorous statistical methods for grouping species into plant functional types (PFTs) based on their ecological attributes. This allowed us to determine the number of plant functional types necessary to describe for the selected megaplot forest succession and equilibrium community compositions.

O3 – Strength of plant-plant interactions among saplings varies over time in a wet tropical forest

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Negative density-dependence is one of the most important types of plant-plant interactions hypothesised to drive tree community dynamics in wet tropical forests. Some studies, however, suggest that inter-specific interactions between light-demanding species are also apparent, especially in gaps. In this study we assessed the relative importance of processes of negative density-dependence and inter-specific interactions during the saplings stage of light-demanding tree species in a wet tropical forest. More specifically we used recent techniques of spatial point pattern analysis to find out if the spatial patterns of dead vs. surviving saplings and of sapling size were indicative of these two plant-plant interactions and if their strength varied among the different censuses. In the 50-ha plot of Barro Colorado Island (Panama), we analysed the fate of cohorts of tree saplings (i.e., their diameter at breast height was 1 to 4 cm) that entered a given census each five years form 1985 to 2010. To study the effects of the plant-plant interactions on sapling mortality we used specific test statistics based on pair correlation functions to contrast the data against the random mortality null model. To study the effects of plant-plant interactions on size we used mark correlation functions and tested for spatial correlations in size (or growth) by contrasting the observed data against a null model of random marking. Our results showed that the spatial pattern of saplings showed signals of both, negative density dependence and inter-specific interactions with relative importance changing somewhat among censuses.

O4 – Stochastically driven adult-recruit associations of tree species on Barro Colorado Island

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Tree species of tropical forests may change there spatial positions from recruits to adulthood either in a deterministic or stochastic way. So far, the emerging patterns of adult-recruit associations have seldom been described in a spatially explicit manner.
We therefore analyzed the adult-recruit associations for a total of 61 tree species occurring during five censuses from 1985-2005 in a fully mapped 50-ha neotropical forest plot on Barro Colorado Island (BCI), Panama. We applied a classification scheme to assess the percentages of no association, segregation, partial overlap, and mixing.
In a second analysis we tested if adults and recruits of a species were spatially dependent on the topographic covariates elevation, slope, aspect, convexity, topographical wetness index, and vertical distance to streams. Finally we tested if small- or large-scale association types were dependent on the life traits of species such as shade-tolerance guild, growth form or dispersal agent.
We found that the majority of species showed no associations (51%), followed by mixing (24%), partial overlap (18%), and segregation (7%). However, for 71% of the cases with small-scale mixing and 67% with large-scale mixing niche affiliation with topographic habitats could not have been the causal mechanisms for these positive association patterns and stochastic processes such as dispersal limitation must have been the cause. Furthermore, we found that spatial dependencies on covariates were very low and that these dependencies changed for the different life stage. Life trades were related to the association types such as mixing and segregation but we suspect that the complexity of primary and secondary seed dispersal is one main reason to cause the neutral patterns of random associations.
Overall, we found strong evidence that the tree species diversity on BCI is largely stochastically determined by mechanisms like random dispersal and dispersal limitation. In contrast, effects of environmental filtering and niche dependency on habitats were very weak. We conclude that stochastic effects override deterministic habitat effects on BCI because topographical gradients are not strong enough to shape the species assemblages of this tropical forest plot.

O5 – Pitfalls and some solutions for analysing spatial patterns of canopy gaps

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Nature-oriented forest management tries to emulate natural disturbances by silvicultural treatments. Typical disturbances in Central European semi-natural forests are of small-scale and low intensity. They cause gaps in the main canopy layer, which are hotspots for tree regeneration, since ecological conditions within gaps are usually very different from below-canopy conditions. Survival and species composition of the regenerating cohort are determined by the size and spatial distribution of the gaps as well as the developmental stage of the forest. Gap dynamics is thus a vital process in the continuous development of semi-natural forests.
The analysis of the spatial patterns and dynamics of canopy gaps is impeded by the fact that terrestrial mapping is labour-intensive and tedious and delineating gaps in orthorectified aerial imagery is not

easily possible, since illuminated bushes and understorey trees have the same visual appearance as the main canopy. To correctly identify canopy gaps one needs the third dimension either through stereoscopic interpretation of stereo pairs or additional (photogrammetric) height information. To analyse the spatial pattern of canopy gaps classical methods could not be used, because gaps are large objects compared to the distances between them and can thus not be approximated by points. We propose an adaptation of the pair-correlation function to objects of considerable spatial extent.
A semi-automatic delineation of canopy gaps based on colour, height, and texture information of aerial images and the analysis of the spatial pattern of the canopy gaps is shown exemplary for a near natural forest reserve.

O6 – Effects of topography, soil nutrients and spatial scales of biotic interactions on the distribution of recruits in a tropical forest, Panama

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Understanding the controls of the species distributions is a central issue in ecology and conservation. Here we used the resource selection probability functions (RSPF) and information-theoretic approaches of model selection to assess the relative importance of topography, soil nutrients and biotic interactions at various spatial scales as determinants of the distributions of recruits (i.e., individuals that passed during the past five years with the 1cm DBH threshold) in a fully censused 50-ha plot of Panamanian lowland forest. We analyzed recruits data from the 1985, 1990, 1995, 2000 and 2005 censuses. Biotic variables were calculated as the number of individuals (or total basal area) of all individuals of a given life-form (i.e., canopy tree, midstorey, shrub and understorey) from the previous census within 5, 10, 15, 20, 30, 40, 50m of a focal 5m × 5m quadrat. We built RSPF models, representing all combinations of the three types of variables (i.e., topographic, soil nutrients, and biotic) for each recruit species. The probability that the best model across all censuses included the topographic variables, soil parameters and biotic variables (i.e., summed Akaike weights) averaged approximately 45%, 80% and 94% across species, respectively. The general pattern was that presence of overstorey species at spatial scales >5m and soil nutrients characterized the distribution of recruits. Topographic control however acted in fewer cases as additional constraint. Moreover, the spatial scales (>5m) at which the presence of overstorey affected the distribution of recruits were not temporally constant and varied among recruit species. Comparing the RSPF results to information on species traits showed that gap species, canopy trees and midstorey species tended to produce more accurate models with high area under the receiver operating characteristic curve (AUC) than the shade tolerant and understorey species. In conclusion, presence of overstorey trees in the neighbourhood and soil nutrients appeared to be the dominant controls of the distributions of recruits on BCI.

O7 – Simplicity vs. complexity in plant functional types for tropical forest trees

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When working with tropical forest models, the high number of different species makes it necessary to group them into a lower number of groups called plant functional types. Ideally, each of these groups includes species with very similar characteristics and environmental responses so the least possible amount of detail is lost. When such a grouping is done, it is generally assumed that there is a trade-off between simplicity and manageability on the one hand and complexity and realism on the other. However, there is no universally accepted theory on how this grouping is to be done. Using the established forest model FORMIND, inverse modelling and field data from Barro Colorado Island, we compare groupings which differ in detailedness and the number of plant functional types. We investigate the apparent trade-off between complexity and simplicity and the impact of this trade-off on the simulation of processes like biomass accumulation, diameter distribution and succession.

O8 – What do spatial patterns tell us about tropical forest dynamics?

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The processes that govern species diversity and community structure in tropical forests are expected to have a strong spatial component. Although this has been widely acknowledged, spatial patterns in plant communities have been rarely used to infer details on dynamic processes such as dispersal, recruitment and competition. A simple model to describe the dynamics of tropical forests is provided by the neutral theory of biogeography and biodiversity. However, the classical neutral model is spatially implicit and is thus unable to predict spatial patterns. Spatially-explicit, grid-based extensions of the neutral model have been applied to predict first order spatial patterns, such as species richness at different spatial scales, but so far second order spatial patterns, such as aggregation and segregation have not been considered to infer the parameters of neutral models.

We develop a spatially-explicit and spatially-continuous neutral model, which describes plant interactions based on a zone-of-influence (ZOI) approach. From this model we derive first order spatial statistics, e.g. the density of individuals and species on different spatial scales, as well as second order spatial statistics, i.e. the aggregation and segregation among individuals and species. Using techniques of inverse modelling, we parameterize our model with data from the Barro Colorado Island (BCI) forest dynamics plot in Panama. This allows us to infer dispersal distances, the spatial scale and intensity of competition, and their uncertainties from the tree census data. Our approach evaluates the ability of the model to capture aspects of reality with a variety of spatial patterns that are quantified from the data of the forest plot. Departures form observed patterns suggest extensions to the basic neutral model that we intend to test with spatially-explicit census data during further research.

O9 – Inverse calibration of tropical forest models - results from two case studies in Ecuador and Sri Lanka

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Understanding the vegetation dynamics of tropical forest ecosystems is of great ecological interest, as it connects to some classical ecological questions regarding community stability and succession. It is also increasingly of practical interest, as there is demand for advice regarding the impact of environmental and climatic change. In this context, dynamic forest models are useful tools to explore the consequences of our ecological knowledge, and to make quantitative predictions about the future of forest ecosystems under climatic and environmental change.

One of the main sources of uncertainty regarding the predictions of process-based forest models is their parameterization – tropical forests are highly diverse, and there is often little known about the characteristics particularly of the rare species. Because there usually no information about the characteristics of all species on a site, parameters are typically calibrated inversely, that is, by adjusting parameters to achieve a good match between model predictions and data. For this task, Bayesian methods are increasingly used.

Here, we report on two case studies that use Bayesian statistics to calibrate FORMIND, a tropical forest models, to two field sites in Ecuador and Sri Lanka. We discuss methodological concerns and implementation, and report about our experience regarding the ecological interpretability of inferred parameters. Also, we examine and discuss how different type of field data (equilibrium community composition vs. repeated measurements) affects the uncertainty about parameter estimates. We conclude that Bayesian methods are a promising approach for the calibration of tropical forest models, but good data is needed to impose strong constraints on all parameters that are typically included in process-based forest models.

O10 – Characterising seed rains in complex dispersal systems: Endozoochorous dispersal of shrub communities

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Both intra and interspecific seed aggregations is likely to affect seed fate by, for example, attracting predators and pathogens as well as secondary dispersers, and influencing levels of competition or facilitation. Research on spatially contagious seed dispersal is limited even at the species level, let alone at the community level; however, nearly any dispersal vector disperses multiple species of plants, and multiple dispersal vectors mediate dispersal of nearly any given species of plant. Spatial Point Pattern Analysis (SPPA) is a powerful analytical tool that deals with the statistical analysis of mapped point patterns (e.g., frugivore feces), which comprise the coordinates and additional features of ecological objects (e.g., number and species of seeds within fecal samples). We applied recent extensions of SPPA to describe in detail the spatial correlation structure and interspecific spatial association among seeds dispersed by four mammal species (red fox, Eurasian badger, wild boar, and red deer). In so doing, we used spatial data and seed composition of fecal samples systematically collected during two consecutive dispersal seasons in two sites in southwestern Spain (overall 23,944 seeds within 491 feces). In the first site (a Mediterranean scrubland), our analyses indicated a significant association between the seeds of the dwarf palm *Chamaerops humilis* and the Iberian pear *Pyrus bourgaeana* ($p < 0.05$) at a scale of 40 m. No significant associations at any scale were found between the mastic tree *Pistacea lentiscus* and *C. humilis* or *P. bourgaeana* ($p > 0.210$). In the second site (a juniper forest), our analyses indicated a significant association between the seeds of the blackberry *Rubus ulmifolius* and the Phoenician juniper *Juniperus phoenicea* ($p < 0.05$) at a scale of about 35 m. Conversely, no significant association at any scale was found between the Portuguese crowberry *Corema album* and *R. ulmifolius* or *J. phoenicea* ($p > 0.210$). As whole, our results support the idea that dispersers hold a strong potential to influence the spatial distribution of seeds as well as their likelihood for competitive and facilitative interactions.

O11 – Disturbance mediates tree-species coexistence in New Zealand's rainforests

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Pollen and tree-ring data suggest that infrequent, catastrophic disturbances mediate the coexistence of conifers (gymnosperms) and broadleaved (angiosperm) species in New Zealand’s rainforests. However, the effects of multiple factors (e.g. climatic variation, disturbance, human influence) confound the interpretation of these palaeo-ecological records. Using the forest landscape model LandClim, we aim to simulate long-term forest dynamics in response to catastrophic disturbances under controlled environmental conditions and compare results to palaeo-ecological findings. As a case study, the forest succession following the cataclysmic Taupo eruption (1718 cal BP) at Mt. Hauhungathi in the central North Island of New Zealand was simulated.
Simulation results show good agreement with pollen-records in key spatio-temporal patterns of conifer and angiosperm succession. During succession, conifers initially dominated the landscape after the eruption and continued to persist as important forest-components for centuries due to their extreme longevity (more than 1000 years). After disintegration of this initial stand, they were replaced at lower altitudes by angiosperms due to light competition. In angiosperm dominated areas, significant conifer regeneration only occurred once patch-scale disturbances (e.g. windthrows creating large canopy gaps) were included in the simulation. Resulting age-histograms of conifers showed similar patterns as empirical data from tree-ring analyses once patch-scale disturbances were large and infrequent (at the scale of centuries). Our simulation study therefore highlights the potential of combining palaeo-ecological data and forest landscape modeling and shows how disturbances can mediate the coexistence of conifers and angiosperms in New Zealand’s forests.

O12 – Is herb and tree layer diversity related to the proportion of the dominant tree species in the canopy layer? Studies from beech – sessile oak natural forest of Western Romania

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Modern silvicultural management in Europe increasingly aims to promote mixed stands instead of pure stands and to enhance forest biological diversity. Since in temperate forests the herb layer is the component with highest diversity and thus plays an important role in ecosystem functioning, it is crucial to investigate how canopy tree species composition influences herb layer species richness and abundance. In spite of the increasing number of investigations concering diversity relationship between these two forest layers, the results are still inconsistent. Furthermore, studies among deciduous European species conducted in natural or near-natural forests are limited.
By establishing field sites in Runcu-Grosi Natural Reserve in Western Romania, one of the best preserved natural European beech-sessile oak forests, we investigated whether canopy layer diversity controls the herb layer diversity, as well as identifying possible causal mechanisms. Our results show that herb layer diversity is positively correlated with tree layer diversity. Additionally stands dominated by sessile oak had higher diversity in both the herb and tree layers as compared to beech dominated stands as well as having a more complex vertically differentiated structure. With respect to environmental factors, litter thickness was negatively correlated with herb layer diversity and beech dominated plots had thicker litter layers than oak dominated plots. Soil pH was positively correlated only with the species richness in the tree layer. For several herb layer species indicator species analysis revealed a significant affinity for plots with higher proportion of sessile oak. This research considerably contributes to the understanding of regional biodiversity dynamics in beech-oak forest ecosystems.

P1 – Implies the predominance of beech or sessile oak species in the stand composition specific patterns of stand structure?

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In the last decades, the sustainable forest management, based on principles such as extension of mixed-species stands and close to nature silviculture has started to be a very important topic in the European forestry sector. But in order to manage forests in a natural way, it is necessary to know more about the structure patterns and processes that occur naturally inside them. Numerous studies on remnant natural forests of Eastern and South Europe have been conducted in last time in mixed beech-coniferous virgin forests and pure beech virgin forests, whereas pure or mixed oaks natural forests have been too less investigated, mainly since almost all of the oak forests in Europe have been very intensively managed. Therefore, in one of the best preserved natural European beech-sessile oak forests (Runcu-Grosi Natural Reserve, Western Romania), we focuses on how the predominance of different species in

the stand composition (i.e., beech as shade tolerant species or sessile oak as less shade tolerant species) implies specific patterns of stand structure. Spatial structure patterns were investigated by upper crown profiles, distance methods (Fisher index, Pielou's index, Clark-Evans index), and univariate point-pattern analysis (Ripley function). On the basis of upper crown profiles the predominance of sessile oak led to a high variability in the overstorey layer, while a pronounced uniform character appeared due to a higher beech participation in stand composition. In beech dominated forests (as % of total volume), a higher percentage of the sessile oak was clumped in pure groups, whereas in both beech and sessile oak dominated forests beech species were present randomly distributed.

These species-specific patterns are in agreement with the ecophysiological characteristics of the two species. In conclusion, a better understanding of spatial patterns of different species growing under natural conditions can be a very helpful tool in the establishment and management of artificial mixed stands.

Session 21 – Island biogeography

Chairs: Ingo Hahn, Manuel Steinbauer

O1 – Island environments - a physical description of the world's islands for macroecology and biogeography

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There are approximately 180,000 islands worldwide covering 3 % of the terrestrial surface of the globe and harbouring a disproportionately high number of range-restricted species. However, little is known about the distribution of islands in environmental space and a useful classification that specifically considers islands is currently missing. Here, we present a quantitative ecoregional classification of approximately 18,000 islands worldwide representing most of the world's landmasses surrounded by ocean and larger than 1 km². As decisive variables, we considered area, geographic position, mean annual temperature, annual precipitation, seasonality in temperature and precipitation, climate change velocity since the last glacial maximum, elevational range, distance to the nearest mainland, amount of surrounding landmass as well as past connections to the mainland. The suitability of different measures of island isolation was assessed using spatial multiple regressions for vascular plant species richness on 453 islands as response variable. We used ordination as well as hierarchical and non-hierarchical clustering methods to arrange islands in a multi-dimensional environmental space and to delimit and visualize island ecoregions. We present hyper-volumes of archipelagos within ordination space as a measure of environmental heterogeneity. Our analyses provide insights into the environmental configuration and diversity of the world's islands. The presented classification represents a useful geographic framework for further studies in island biogeography and macroecology.

O2 – Soil importance in a threatened island ecosystem: Impact of the 2010 Chilean tsunami on biotic and abiotic components

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Soil types, especially in restricted ecosystems, can represent an important basis for human, plant, and animal life (e.g. Hahn & Wheeler 2001). Tsunamis, like the 2010 tsunami in Chile, have severe impacts on the life in general along the coast side (Prasad et al. 2010). E.g., for 3 % of the human population of Robinson Crusoe Island this event was mortal. This Chilean island, although having only an area of 47 qkm, is also the prime conservation hot-spot within the country, e.g. hosting rare soil types and c. 20 % of the county's endemic bird species. Very little is known in general about the impacts of tsunamis on soils, flora and fauna. However, the impact on mineral grain transport (and thus soils) was found to be extensive (Spiske & Bahlburg 2011). On Robinson Crusoe the endemic hummingbird, the Juan Fernandez

Firecrown (*Sephanoides fernandensis*), showed a total population size of about 1100 individuals. As a nectar feeder it highly depends on flowering plants, and has co-evaluated with an endemic Asteraceen species which is mainly found along the coast side. In turn, these plants depend on fertile soils and thus also need supply from nutritious and protective mould/humus layers. In this study we investigated how a tsunami functions as an example for a natural catastrophe critically endangering a soil-plant-bird system. The importance of specific regional soil types is discussed on the background of plant species requirements.

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O3 – Elevation-driven ecological isolation

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The degree of diversification on islands or island like mountains is suspected to be positively influenced by isolation, time and environmental heterogeneity. A differentiation of these influences, however, is a non-trivial task as elevation (i.e. an indicator for habitat diversity) and island age (i.e. an indicator for the time available for diversification) are often correlated. In addition, the geographic distance to source ecosystems might differ among habitats, which could lead to habitat-specific reduction of species immigration, niche occupation and diversification.
We used the percentage of single island endemic species (pSIE) as an indicator for diversification on islands. With data from different island systems (oceanic and continental) and at different resolutions (within islands and on entire archipelagos) we found evidence for an *elevation-driven ecological isolation* that leads to distinctly higher diversification in high-elevation ecosystems. Consequently, these high-elevation ecosystems on island or island like mountains typically support a higher degree of endemic species than their low elevation counterparts. High-elevation ecosystems also pose a special opportunity when investigating the basic processes of island biogeography as they are the part of an island that is fastest eroded in the ontogeny of an oceanic island. This leaves the highly specialised biota the least time to establish and move on to a newly emerging island within the archipelago.

O4 – Massive structural and compositional changes over two decades in forest fragments near Kampala, Uganda

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1. Human induced land conversion is causing loss of tropical forests, with the most dramatic loss happening outside protected areas. Private urban forests harbour considerable biodiversity, however, they are under greater threat than protected areas, particularly from urbanisation and agriculture. The extent to which they provide a viable option for biodiversity management outside formally protected areas remains under-researched.
2. We contribute to filling this research gap by re-sampling a unique dataset, a detailed survey from 1990 of private and sacred forest fragments and a reserved forest near Kampala, Uganda.
3. Fifty percent of all fragments were lost over 20 years, and most of the remainder shrank in size. Also forest structure, composition showed dramatic changes with 63% of the fragments showing high temporal species turnover. At same time species richness increased in 54% of the forests over re-sample period. Forest ownership affected the fate of the forests, with higher loss in privately owned forests.
4. Our data illustrate that the private and sacred forest fragments retain IUCN listed vulnerable and near threatened species, and thus are important for biodiversity conservation.
5. Synthesis and applications. Our study demonstrates that ownership affects the fate of forest fragments. Furthermore, the presence of 'vulnerable' and 'endangered' species indicates conservation value of the fragments, and signals the need to protect them from further human disturbances.

O5 – Reaction of plant groups in a recovering tropical forest

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Forests in densely populated developing countries are more likely to be subjected to intensive use by people. The resilience of component species to disturbance therefore affects the sustainability of the forest resource. Mabira Forest in Uganda is a forest with a history of both management and unmanaged intensive use: nowadays a 300 km^2 forest reserve about 50 km from the centre of Kampala, it consists of a mosaic of patches disturbed over different time periods.
Broad plant functional groups present in Mabira respond to disturbance in different ways. We surveyed large trees, woody shrubs and saplings, ferns, and herbs, in stands that had either been relatively undisturbed since the 1950s, managed since the 1950s, or encroached by settlers in the 1980s. We compared the similarities between samples taken from the four plant groups: the datasets for each were analysed in parallel, then the arrangement of the samples in ordination space compared. The ordinations were not correlated with one another, indicating very different responses to disturbance or other environmental gradients. Given the different responses we then used constrained ordinations with backwards-selection modelling to find important environmental variables for each plant group. Trees, shrubs and saplings were influenced by time since last disturbance, ferns were influenced by distance from streams, *ie* microclimate, and non-woody angiosperms by leaf litter cover *ie* microhabitat.

Herb and fern species richness were both higher in old-growth stands, whereas large tree species richness was higher in old secondary stands.
Conservation of both timber and non-timber resources, as well as biodiversity as an intrinsic benefit, will therefore depend on the sensitivity of the relevant plant groups to specific aspects of disturbance impact. Holistic forest management plans should take these differences into account in order to maximise sustainability.

O6 – Monitoring tree-bark arthropod diversity along altitudinal and structural gradients in tropical forests

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For a worldwide targeted evaluation of patterns and gradients of species diversity in our MACAG project (*Monitoring of Arthropods along Climate and Altitude Gradients*, see GfÖ 2009 Meeting abstract book), we are sampling arthropod communities from (alive) tree bark by using bark spray method in a standard procedure, for a quick assessment, monitoring and evaluation of arthropod fauna diversity and turnover in primeval and near-to-nature forests.
Here we present final results of our sampling in Podocarpus NP in Ecuador from 2007, 2008 and 2009 along an altitudinal gradient from 1,000 to 3,000 m. Beetles, harvestmen and pseudoscorpions show clear elevational gradients in diversity, corresponding to structural properties of the tree bark (roughness, epiphyte and climber coverage, dbh) which in turn are significantly correlated to altitudinal level.
Diversity and degree of species accumulation are very different between the beetles (high, no saturation) and the two arachnid taxa (low, near saturation), as is the altitudinal pattern: Beetles show a middomain-like peak of diversity in the mountain cloudforest at 2,000 m, a tropical 'singleton' phenomenon in the warm rainforest formations at 1,000 m, and lowest species richness in the temperate zone (Paramo transition forest at 3,000 m), whereas the harvestmen and pseudoscorpions follow more structural (three-dimensional) bark properties, i.e. rough bark and high epiphyte coverage at 2,000 m and esp. at 3,000 m. All three elev. levels show distinct assemblages, with only a few 'intermediate' species between adjacent levels. No between-year differences show up in ordinations, the results are reproducible, thus making bark arthopod assemblages a suitable tool for monitoring and calculation of diversity patterns and climate change responses.
Results are discussed in comparison with samplings from French Guyana (lowland Amazonian), Vanuatu (Oceania) and Queensland (subtropical-temperate).

O7 – The pygmy mole cricket *Xya variegata* as an indicator for dynamic river systems

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Disturbance-dependent ecosystems such as natural floodplains harbour many, partly highly specialised and endangered insect species. One of these species is the pygmy mole cricket *Xya variegata* Latreille, 1809 (Orthoptera: Tridactylidae), a floodplain specialist of the Ponto-Mediterranean region. However, as in many endangered insect species detailed knowledge on the habitat requirements of *X. variegata* is widely unknown, even though such knowledge is of particular importance for successful nature conservation. The aim of this study was to analyze the ecological demands of *X. variegata* and to verify the species' suitability as an indicator for dynamic river systems. Therefore, microhabitat analyses were conducted in August 2010 on 42 plots in a nearly natural floodplain of the western Spanish Pyrenees. The results show that patch occupancy in *X. variegata* was determined by a high amount of fine sediment particles and low vegetation coverage. Moreover, population densities were positively correlated with low vegetation and low gravel/stone coverage. The plots with the highest population densities (29 and 36 individuals/0.5 m^2) had no vegetation at all. Habitats of *X. variegata* were usually located in a greater distance to the main channel; that is areas where fine sediment particles were deposited after a flood event. Disturbance is thus mandatory for the persistence of the species and makes *X. variegata* a suitable indicator for dynamic river systems. There is an urgent need to conserve and restore dynamic floodplains as one of the last wildernesses in Europe and to maintain their unique plant and animal communities.

O8 – Death and uncertainty: Bayesian modeling of the association between life span and reproductive investment in birds

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The question of why some species live a long time, and others only a short time, has fascinated scientists for centuries. Birds are an ideal group to investigate this topic because they inhabit a wide range of ecological niches and exhibit a wide range of life histories and life expectancies. Here we use maximum-recorded life span data obtained from the ringing records of the British Trust for Ornithology (BTO) to investigate the association between reproductive investment decisions and life span in approximately 200 European bird species. Maximum-recorded life span has previously been criticized for being sensitive to sample size variation; greater sample sizes lead to greater apparent life spans. However, we use a novel Bayesian state-space modeling approach that accounts for this problem and other data issues including truncation (unknown birth date) and censoring (unnatural death) while simultaneously controlling for phylogenetic relatedness. We show that the inherent problems of using the sample-size-sensitive measure of maximum-recorded life span can be overcome, along with other data quality issues. We demonstrate that accounting for phylogenetic relatedness weakens the association between reproductive strategy and life span, implying that inherited characteristics play a dominant role. In addition, our model infers that we consistently underestimate life span in some species groups.

O9 – Adjustment of movement behavior of black bears (*Ursus americanus*) related to different risk levels imposed by hunting

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The risk allocation hypothesis (RAH) deals with prey decisions about the optimal trade-off between predator avoidance behavior and feeding behavior (energy intake). Human hunters as a predator may influence behavior of free-ranging mammals, including large carnivores such as black bears (*Ursus americanus*). The possible influence of hunters on black bear behavior is poorly understood. We therefore studied whether black bear movement behavior changed with different risk levels induced by different forms of human behavior. These included the period when hunters train their dogs (low risk level) and the period when hunters use dogs for hunting (high risk level). For this purpose, we analyzed the average minimum distance of bears to paved and gravel roads, and the frequency of bears crossing both road types for 10.000 GPS locations. Behavioral changes of 19 bears within the dog training period and 11 bears within the dog hunting period were analyzed with linear mixed models and generalized linear mixed models, using season, daytime and sex as predictors, and applying an information-theoretic approach (Akaike's information criterion) for model selection. Comparison with random points and a rotation was used to test model quality and the effect of autocorrelation. As the predicted risk level to bears increased, mean distance of bears to paved roads decreased. This reduction in distance was also observed at night. Average distances of bears to gravel roads showed a reverse pattern. Frequency of crossing roads at night during the hunting period was eight times higher for paved and four times higher for gravel roads at night than during the day of the same period. Our results demonstrate that bears adjusted their movement behavior to changes in risk levels derived from the presence or absence of human activities related to sports hunting.

P1 – Plant differentiation on oceanic archipelagos in dependence of island age

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The "general dynamic model of island biogeography" (GDM), provided by *Whittaker et al. (2008)* developed to become the current, widely accepted theoretical concept within island biogeography. Its aim is to describe general biotic patterns within oceanic archipelagos.
Within this study, it will be tested, whether some of the predictions derived from the GDM can be supported at a taxonomic higher level. Therefore, four different plant families (*Asteraceae*, *Lamiaceae*, *Fabaceae* and *Poaceae*) within six oceanic archipelagos (Azores, Canaries, Cape Verde, Galápagos, Hawai'i and Marquesas) have been analyzed.
Following *Whittaker et al. (2008)* the number of Singles Island Endemics (nSIE) as well as the percentage of Single Island Endemics (pSIE), were investigated to determine the speciation processes within the plant families in dependence of the geological ages of the islands, within the archipelagos, and in

dependence of the respective island areas. Hence, we used linear mixed effect modeling to test the statistical approach (the logATT² model) gained from the GDM.
Our analysis showed that applied on a taxonomic higher level the logATT² model does not provide the most parsimonious approach for island biogeographical patterns. In contrast to the expected hump-shape pattern, our research produced two types of trends. One, where highest nSIE occurred nearly from the beginning leading to the conclusion that rapid speciation might be involved. And second, the case, where the nSIE increases with island age. Hence it can be concluded, that an overlay of these two types leads to the hump-shape pattern when observing all occurring plant families. Nevertheless, does the framework provided within the GDM, leave enough freedom for interpreting the obtained results.

P2 – Artificial islandification in the Tucuruí dam reservoir in Brazil: effects on the vegetation

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Islandification of formerly closed forest occurs when rivers are dammed up and huge lakes flood the lower sites, leaving islands on earlier mountain tops. This way, the construction of hydroelectric dams has been contributing significantly to forest fragmentation, especially in tropical regions. Alterations at edges of forest fragments impact plant communities that suffer increases in tree damage. High death rates and decreased seedling recruitment are the consequences. In the present study, we analyzed the vegetation on 17 islands of 8-100 hectares in a fragmented landscape caused by construction of a hydroelectric power plant in the Brazilian Amazon. We studied variations in forest structure between the margin and interiors of in the Tucuruí dam reservoir, in two plots (30 and >100m from the margin) per island. Mean tree density, basal area, seedling density and forest cover did not significantly differ between marginal and interior island plots. Also, no significant differences were found in liana density, number of dead trees or tree damage. The peculiar topographic conditions associated with the matrix habitat and shapes of the island seem to extend edge effects to the islands' centers independently of the island size, giving the interior similar physical microclimatic conditions as are found at the edges. We propose a protocol for assessing the ecological impacts of edge effects in fragments of natural habitat surrounded by induced (artificial) edges. The protocol involves three steps: (1) identification of focal taxa of particular conservation or management interest, (2) measurement of an "edge function" that describes the response of these taxa to induced edges, and (3) use of a "Core-Area Model" to extrapolate edge function parameters to existing or novel situations.

Session 22 – Macroecology

Chairs: Holger Kreft, Juliano Sarmento Cabral

O1 – Integrating paleo-reconstructions, phylogenies and species distribution data to elucidate deep-time imprints on species assemblages worldwide

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Understanding the historical assembly and present-day structure of regional species assemblages requires the integration of ecological, paleo-geographic, and phylogenetic information. Using the pantropical, monocotyledonous palm family (Arecaceae, n = 2440 species) as a case study, we combine global species distribution data, a complete genus-level phylogeny, and paleo-reconstructions of climate and biomes to test for Cenozoic (65 million years) imprints on phylogenetic assemblage structure worldwide. We find a strong imprint on phylogenetic clustering due to geographic isolation and *in situ* diversification, especially in the Neotropics and on islands with spectacular palm radiations. Differences in the degree of phylogenetic clustering among biogeographic realms are related to differential losses of tropical rainforests during the Cenozoic, but not to the cumulative area of tropical rainforest over geological time. A largely random phylogenetic assemblage structure in Africa coincides with severe losses of rainforest area, especially after the Miocene. More recent events also appear to be influential: phylogenetic clustering increases with increasing intensity of Quaternary glacial-interglacial climatic oscillations in South America and to a lesser extent Africa, indicating that specific clades perform better in climatically unstable regions.Our results suggest that the integration of paleo-reconstructions and phylogenetic information with data on species distributions has great potential to obtain a deeper understanding of how geographic isolation and changing climate and habitat loss throughout the Cenozoic have affected macro-scale biodiversity patterns.

O2 – Dispersal, palm trees, and global patterns of biodiversity

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In this talk I will outline and present the first results of a new project investigating the effects of dispersal on patterns of biodiversity, using tropical trees as a case study. Dispersal, or the movement of organisms, is thought to be a key variable in both ecology and evolution. The distance a seed moves before germinating, for example, is important in determining the environment it will grow in, the competition and threats it will face from other species, the level of genetic mixing it causes within its species and the likelihood that it might found a new species or save its own species from extinction. But how important is dispersal compared to other factors that affect diversity patterns, such as global

variation in climate? This project aims to address this question by quantifying both long- and short-distance dispersal ability for many species of palms and other tropical trees, and testing how well these dispersal measures predict taxonomic and spatial patterns of diversity. I hope with this talk to stimulate discussion about the role of dispersal in macroecology, and how we can best study it.

O3 – Compositional, functional, and phylogenetic beta diversity reveal dispersal limitation among acidic grassland sites in Atlantic Europe

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During the last two decades, plant ecology has seen a paradigm shift from focusing on species-based analyses to approaches based on the functional properties and phylogenetic relationships of the studied species. Recently, this has also been applied to studying patterns of beta-diversity and it has been shown that combining compositional, functional and phylogenetic beta-diversity can improve understanding community assembly processes. A positive relationship between geographic distance and beta diversity suggests dispersal limitation is important, whereas a positive relationship between beta diversity and environmental distance indicates environmental filtering. We analyzed a data set of acidic grasslands sampled over a large geographical gradient, situated in the biogeographical region of Atlantic Europe. We constructed six matrices, three containing the information on compositional, functional and phylogenetic beta-diversity between sites, and three distance matrices, based on climatic variables, soil variables, and geographic location. A series of partial Mantel tests were applied to these matrices to analyze the influence of the abiotic factors (soil and climate) and geographic distance on the three forms of beta-diversity. The most consistent pattern was a significant influence of geographic distance on all three forms of beta diversity, whereas climate had no direct effect on beta diversity. Environmental distance in terms of soil variables influenced compositional and phylogenetic, but not functional beta diversity. These results indicate that abiotic factors, and thus environmental filtering, are of minor importance, at least at the scales considered here. On the other hand, dispersal limitation across the large geographical distance covered in the data plays the major role in explaining the difference in species composition, function and phylogeny between sites.

O4 – Geographical sampling bias in Chinese distribution database and its implication for macroecological analyses

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Primary species distribution data have become increasingly available in recent years contributing to an explosion of studies documenting broad-scale geographical patterns in biodiversity and exploring the underlying processes. However, geographical sampling bias is a common feature of distribution

databases, and this might have profound influences in the macroecological analyses. Here, we quantify the inventory incompleteness of 2,377 Chinese counties and test whether geographical sampling bias affects the perception and interpretation of species richness and richness-environment relationships. We further identify the main factors contributing to the geographical bias in the surveys of Chinese flora. A large database comprising 4,236,768 records from specimens and literature for 29,012 species of vascular plants in China with county-level information was assembled. We calculated species accumulation curves (SACs) for each county and used the curvilinearity of SACs as the proxy of inventory incompleteness. We created data subsets with different levels of inventory incompleteness by successively excluding poorly sampled counties. Spatial and non-spatial regression models were used to investigate relationships between species richness of the subsets and environmental variables, and to predict spatial patterns of vascular plant species richness in China. The log numbers of records (collecting efforts) and documented species were almost perfectly correlated (r = 0.97). 91% of all Chinese counties were identified to be undersampled. After minimizing inventory incompleteness, the overall explanatory power of environmental variables on species richness markedly increased, and the strongest predictor switched from elevational range to annual wet days. Environmental models parameterized by more complete inventories yielded better spatial predictions of species richness. We conclude that even large distribution databases are prone to geographical sampling bias with far reaching implications for the perception and interpretation of macroecological patterns. Our study highlights the importance of evaluating data quality before using such databases for any theoretical and applied questions.

O5 – Magnitude, geography and correlates of the completeness of globally mobilized species distribution point data

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An accurate documentation of global biodiversity is essential for advancing ecological research and for developing robust conservation strategies. After centuries of taxonomic and biogeographic research, our knowledge of the geographic distribution of species is still far from complete – the so-called “Wallacean shortfall”. Large quantities of primary biodiversity data from natural history collections and citizen science endeavors have become freely accessible via the Global Biodiversity Information Facility (GBIF), but these data are mostly *ad hoc* and have inherited taxonomic, geographic, environmental, and temporal biases. In an attempt to quantify these biases, we focused on three comparatively well-known vertebrate groups (amphibians, birds, and mammals). We first established global patterns of species richness at coarse scales, based on high-quality expert range maps. Against this reference benchmark, we then tested for the level of completeness of GBIF data at different spatial resolutions, expressed as the proportion of expert-opinion species richness covered by the data. While species richness in parts of North America, Europe, and Australia is fairly well-represented by GBIF data, especially at the coarsest scales, most regions have data that consistently cover less than 50% of expert-opinion species richness across all scales. Even for relatively well-known taxonomic groups such as terrestrial vertebrates, biodiversity records are completely lacking for large parts of the distributional ranges. In a further step, we correlated inventory completeness with environmental and socioeconomic factors to investigate specific causes for regional knowledge gaps. Our results provide a necessary quantification of inventory completeness in the world's largest, and still growing, primary biodiversity data-store. Examining these measures along with possible drivers, inform new strategies for prioritization of regions and taxa in order to most quickly and efficiently close existing data and knowledge gaps.

O6 – North America's Pacific coastal rainforest under climate change: Deriving recommendations for conservation management from spatial modeling approaches

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The temperate rainforests distributed along the Pacific coast of North America represent the largest remaining amount of this rainforest type on Earth. Temperate rainforests in this region are characterized by high productivity and relevant ecosystem services such as carbon sequestration and wild salmon runs. These rainforests also show high dependencies on climatic parameters associated with cool, moist climates. Hence, projected increases in temperatures and changes in precipitation patterns by 2080 may severely affect this ecosystem that is already threatened by land-use pressures.
Two model approaches were applied to investigate shifting climate niches of eight major tree species, two lichen species, and changes in dominant vegetation types. We predicted current and future potential distributions of focal species as well as future vegetation stability by using climate niche and dynamic vegetation models. Climate data from three downscaled general circulation models and two emission scenarios were used to capture uncertainty inherent to climate predictions.
Obtained results show climate niche losses in southern parts of the temperate rainforests and polewards shifts in their northern regions for the majority of modeled species. Coast redwood, in particular, shows high vulnerability to climate change since nearly its entire baseline climate niche is predicated to be lost. Moreover, potential areas of vegetation stability and future climatic refugia maintaining intact forests were identified.
Main conclusions derived from our modeling results are: (1) protect source populations in intact areas of stable climate as these are best expected to sustain climate change; (2) maintain and restore landscape connectivity especially in highly fragmented areas enabling dispersal; (3) reduce non-climatic ecosystem stressors, thus, strengthening ecosystem resilience; and (4) incorporate climate change into reserve management and design by protecting local climate refugia.

O7 – The spatial pattern of species richness in European forests reveals the influence of land-use on forest specialist species

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During the last few decades, ecologists have increased their interest in describing and explaining global patterns of plant diversity. However, the lack of consistent and extensive data at national, continental and global scales makes it difficult to conduct global diversity studies.
We aim to discover how landscape- and local-scale conditions determine understory forest species richness, paying special attention to the potential influence of human-related activities. By using data of the ICP-forest project (750 plots widely distributed around Europe), we quantified understory species richness dividing it into forest specialists and generalists (since we expect that not all species will be influenced equally by human activities). Similarly, using large-scale grid-based maps we quantified the generalist and specialist plant species pool for each region. As explanatory factors, we considered: 1) climatic and topographic conditions; 2) land-use and human related factors (CORINE land-use maps) and 3) local environmental conditions (forest canopy and understory plant species abundance). Finally, we related specialist and generalist plant species richness distribution to these explanatory variables.
Our results indicate that although patterns of plant diversity in forest specialist and generalist are correlated, these two components of species diversity are explained by different landscape- and local-scale variables. Species richness of forest specialists was higher in plots where the canopy is dominated by broad-leaved forests. We also found that forest specialist richness was higher in regions dominated by broad-leaved forests while it was lower in zones dominated by coniferous forests or agricultural land. Therefore, forest species richness depends on the landscape-scale distribution of broad-leaved forests, probably because those forests have been the dominant habitat in the continent for Millennia. Conversely, generalist species are more abundant in coniferous dominated plots and they are not influenced by the distribution of forest patches in the landscape. Finally, species richness of forest specialists as well as more generalist plant species is positively related with plant cover in the understory, pointing to the positive productivity-diversity relationship in forests.

O8 – Available niche breadth explains the range sizes of forest vascular plants in Germany

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The positive interspecific relationship between range size and abundance of species is one of the most pervasive patterns in ecology, but the mechanisms behind remain elusive.
Here, we examine whether niche breadth and niche position as well as a compound measure of the two variables contribute to explain the large-scale distribution and local abundance of vascular plant species in deciduous forests in North-western Germany.
We collected occurrence data for 30 forest vascular plants on local (cover abundance in sample plots), regional, national and continental (number of occupied grid cells in the Weser-Elbe region, Germany and Eurasia, respectively) scales and determined niche breadth and position for soil pH and light based on measurements in 46 sites for common and rare species. Frequency distributions of pH values on regional and national scales were used to calculate 'available niche breadth'.

Results showed that the local abundance and continental distribution of species was unaffected by the niche variables. Regional range size was negatively correlated with pH niche position and tended to be positively correlated with light niche breadth, while national range size was positively affected by pH niche breadth. 'Available niche breadth' generally explained the regional and national distribution better than either niche breadth or position alone.
We conclude that niche breadth and position contributed to explain the regional and national distributions of the studied species, but the compound variable 'available niche breadth' related far better to the range sizes. This makes sense, because species with broad ecological amplitudes and main occurrences in widespread habitats are likely to have larger range sizes than species with contrasting attributes. The variability of the influence of the niche variables across range sizes probably indicates a scale dependence: from continental to more regional scales, the explanatory power of the climatic niche variables decreases, while that of the soil and light niches increases.

O9 – Species, phylogenetic and functional diversity of avian frugivores along an altitudinal gradient in the tropical Andes

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Tropical mountains are often very diverse, with species richness generally decreasing with increasing elevation. This high diversity is often attributed to competition between co-occurring species and a high species turnover between elevations, whereas the decrease of species richness towards higher elevations is usually attributed to increasing harshness of environmental conditions. In this study, we investigated patterns of alpha and beta diversity for a feeding guild competing for the same resources to evaluate the influence of biotic interactions and environmental conditions on community structure. We used frugivorous bird species because of their important role for seed dispersal in tropical forests. We studied twelve communities of frugivorous bird species along a 3.3 km altitudinal transect from the lowlands to the tree line in the Andes of Peru. We investigated alpha and beta components of species richness, phylogenetic and functional diversity, as well as the phylogenetic and functional structure of the communities. Species richness and phylogenetic and functional diversity decreased monotonically with increasing elevation, consistent with increasing habitat filtering. Patterns of beta diversity showed a separation of the bird communities into highland and lowland communities. In the lowland communities, species were phylogenetically and functionally less similar than expected from null models, suggesting an effect of biotic interactions on community structure. By contrast, species in the highland communities were phylogenetically and functionally more similar than expected, suggesting an influence of habitat filtering in these communities. The break point between lowland and highland communities implies that biotic and abiotic filters in the foothill region act as a barrier for the vertical distribution of frugivorous bird species in tropical mountains. This barrier may impair the uphill movement of these bird species as a response to climatic changes.

O10 – Explaining macroecology from population dynamics: linking stochastic, metabolic, ecological and evolutionary processes

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Macroecological studies mostly involve data analysis at coarse resolutions, often neglecting local processes. Moreover, only few mechanistic approaches have been developed in macroecology, and these also concentrate on large-scale processes. We present a multi-species model that simulates local-population level (demography, biotic interactions, speciation) processes under a stochastic and metabolic framework. Stage-structured populations of species with different traits and habitat requirements competed for space in virtual landscapes. We considered density-independent (temperature) and competition-mediated density-dependent variables (space) fully representing the Hutchinsonian niche concept. We investigated emerging macroecological patterns (range filling, species richness and speciation). Species richness showed complex patterns related to landscape age, isolation, area, and temperature. Over half of all species were unable to fill their potential range and 11% of all species had their highest abundances shifted towards suboptimum conditions. Factors that decreased the species ability to fill their ranges included stronger competition pressure (i.e. increasing species richness) and traits unrelated to climate (i.e. Allee effects and low dispersal ability). Species were selected to avoid direct competition with ecologically similar species and speciation patterns varied with habitat size and isolation. Results indicate a strong influence of local demographic and competition constraints on patterns at large spatiotemporal scales. Hence, macroecological models neglecting these processes might be biased. Moreover, competitive exclusion provides a mechanistic explanation for the low spatial transferability of single-species niche models. Our approach offers a theoretical tool for investigating large-scale dynamics emerging from local population-level processes.

O11 – Predictive modelling of treeline shift due to climate change in Finland

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Our study aims at gaining insights into the processes determining the current treeline in Finnish Lapland. This understanding will help learning whether an ongoing climate change in Northern Finland will lead to a range shift of some tree species and whether there are non-climatic factors limiting the northwards shift. The analysis bases on the 7th and 9th National Forest Inventory (NFI7: 1977-1984, NFI9: 1996-2003) in Finland as well as meteorological measurements and interpolations from the Finnish Meteorological Institute. We use two approaches to model the basal area of the three dominant tree species in Finnish Lapland, i.e. *Pinus sylvestris*, *Picea abies* and *Betula pubescens*: i) Boosted Regression Trees (BRTs) – an advanced statistical modelling method, and ii) the process-based model LPJ-GUESS which explicitly considers population dynamics (establishment and mortality) as well as soil hydrology.

When estimated and applied within one time period, the statistical models are very well capable of capturing the patterns of species' occurrences although they underestimate abundances. In case of hindcasting and forecasting, however, the BRTs fail to even depict the position of treelines correctly. We investigated and found that this application does indeed imply extrapolation to novel environments (i.e. predictor combinations not sampled in the training data). In contrast, the process-based model in all cases is not able to correctly model the treelines either, suggesting that important processes limiting the species in question are missing in the model implementation. We conclude that climate change leads to new, hitherto unexperienced environmental conditions which forbid predictions with statistical models alone. They can, however, help to pinpoint important processes that need to be implemented in process-based models.

O12 – Microclimatic variability within complex landscape

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The microclimate influence distribution of many species on small spatial scale, but could also significantly change large-scale pattern of species distribution forming sheltered localities on both ends of climatic gradient. We performed detailed (30 min. interval) and more than 1 year lasting measurement of air temperature near the ground and of soil moisture in order to describe: i) daily and seasonal dynamic of microclimate and, ii) to assess differences of microclimate to mezoclimate represented by standard meteorological station. We used newly developed, autonomous unit TMS1 to measure and log temperature directly at the soil surface, 10 cm below and 15 cm above it and soil moisture in the first 15 cm below ground. About 300 TMS1 units were installed in 2010 along an elevation gradient in 6 valleys of sandstone landscape in the National park Bohemian Switzerland (Czech Republic). Individual units were placed in regular distance along valley floors and on several profiles perpendicular to valley floor in the strata given by the same relative height above the floor. Our results confirmed expected temperature inversion in the bottom of the valleys. On the other hand microclimate in deep valleys is more stable, with colder temperatures during the vegetation period but warmer during the winter period. Such colder but more stable climate allow occurrence of many oceanic, mountain or even alpine species in this low elevation region. Comparison of average daily temperature from local meteorological station and our measurement revealed large differences between mezo- and microclimatic condition, reaching magnitude of 20 °C in the area of several km^2. This huge microclimatic variability has important consequences for predicting impacts of climate change. While large-scale shifts in species distribution are predicted, we showed that small-scale heterogeneity will allow species to adjust to climate change by shifting to suitable habitats within their current ranges.

O13 – The macroecology of multiple threats: Interacting challenges for biodiversity

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Current and future climate change is widely expected to have unprecedented effects on Earth's biodiversity. In fact, studies with predictions of distribution changes, population declines and species extinctions are rapidly accumulating. However, in addition to climate change other threats may impose even greater challenges to species and ecosystems, namely habitat fragmentation and destruction, caused by anthropogenic land-use changes. Here, I assess the potential impacts of global threats to biodiversity using different conceptual and modelling approaches. Firstly, in a study on the geography of future threats for global amphibian diversity I will show that the spatial additivity of different threat factors could jeopardize amphibian diversity more than previous, mono-causal, assessments have suggested. Secondly, using the distributions of European dragon- and damselflies, I assess the interface of ecological adaptations and the evolution of dispersal. In particular, I will show how habitat stability may influence range dynamics and dispersal ability, and therefore the potential to respond to climate change. Finally, based on these empirical studies, I will discuss species' chances to respond successfully to anthropogenic threats from climate change and the continuing destruction and fragmentation of natural habitats.

O14 – Improving conservation planning at the global scale based on differing indicators of cost-effectiveness

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The most direct way of addressing the socio-economic dimension of conservation planning is to focus on the improvement of the cost-effectivenessof proposed conservation measures. Currently studies integrate geographic information on agricultural production and on agricultural output prices to model financial benefits and opportunity costs of agricultural land. Intersecting these data with spatial information on species richness, cost-effectiveness ratings are calculated. The studies show that the cost-effectiveness of a global network of protected areas can be substantially improved using optimization strategies that account for both, economic and ecological data. Typical shortcommings of recent studies include reliance on simplistic models of agricultural opportunity cost – e.g., Naidoo & Iwamura 2007 use global averages for agricultural prices, disregard production costs and multiple cropping, and do not account for differences between industrial and peasant production. Likewise, conservation outcomes are approximated by species richness data not accounting for differences in species range sizes.
Our study presents several improvements: (i) a more detailed cost model accounts for a wider range of spatial differences in agricultural production and for production costs, (ii) cost-effectiveness is also calculated for currently undeveloped, pristine habitats, and (iii) endemism richness is used as a measure representing the specific contribution of an area to global biodiversity.
Conservation priorities based on endemism richness of vascular plants and of terrestrial vertebrates are highly correlated (r=0.90). Compared to choosing protected areas based on endemism richness alone, choosing sites based on cost-effectiveness results in much lower agricultural opportunity costs for given

conservation targets. The regions with the highest agricultural opportunity cost of remaining habitat are the Caribbean and New Caledonia. These regions constitute two "biodiversity hotspots" characterized by high historic habitat loss. Magnitude and spatial distribution of agricultural opportunity costs differ markedly from Naidoo & Iwamura (2007). The opportunity costs of remaining pristine habitats (e.g. in the Amazon, the Congo basin, Indonesia, and New Guinea) will be substantial in the future. For India and China, we find relatively lower opportunity cost reflecting prevalent peasant farming and low agricultural output prices. Overall, the results stress the importance of a cost-effectiveness approach to global conservation planning but caution against the impact of differing methodologies.

P1 – Meta-analysis of the relationship between habitat heterogeneity and species richness

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A major goal in macroecology is to explain the spatial variation in species richness worldwide. The habitat heterogeneity hypothesis states that structurally or compositionally diverse habitats harbour more species because they provide more niche space and/or facilitate speciation. The importance of habitat diversity for species richness patterns has been shown many times, but compared with the influence of, e.g., climate, the concept remains poorly understood. We therefore conduct a systematic review to summarize the existing literature on habitat heterogeneity and species richness. Almost 200 different measures used to quantify habitat diversity and structure were identified and classified in terms of their subject and methodology. In a formal meta-analysis of more than 150 studies comprising approximately 500 datasets, we determined the overall effect of habitat heterogeneity on species richness of terrestrial plants and animals. Even though negative relationships have sometimes been reported, we found a significantly positive average effect size. We use moderator analyses to reveal different trends among organism groups, spatial scales, study methodology, and geographic or ecological settings. In addition to new insights, existing ideas and hypotheses could be formally confirmed by our mixed effects models. These include the close relationship of habitat diversity with area and its larger influence on species richness in higher energy regions. A major concern in meta-analysis is publication bias (i.e. studies showing statistically insignificant or small effects being less likely to be published), which potentially leads to overestimated effect sizes. However, diagnostic tools such as funnel plot, rank correlation test and fail-safe number suggest that our results are not flawed by publication bias.

P2 – Vegetation survey and spatial modeling of Miombo woodlands in south-central Angola

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Information on composition and biodiversity of the vegetation in Angola is outdated or lacking, mainly due to a long period of civil war. However, fast economic development and changes in land use urgently require this kind of information to ensure sustainable resource management. Within the framework of the project "The Future Okavango", the vegetation of the two subcatchments Río Cuchi and Río Cuelei

of the Okavango River has been surveyed. This study serves as a pilot study to investigate methodological steps to extrapolate vegetation data in a region with very limited environmental and ecological data.
The study region is in large parts inaccessible and high risk of landmines make field work challenging. Therefore, random points for vegetation plots were generated in a 500m buffer along demined roads. We used a nested design of one 10x10m plot within a 20x50 m plot. In the small plots all vascular plant species and their cover were recorded. In order to cover the high diversity of woody plants in Miombo woodlands all tree and shrub species were recorded in the larger plots.
Vegetation units were aggregated using isometric feature mapping followed by cluster analysis. The potential distribution of vegetation units was modeled with the "Biomod" package in R. Bioclimatic data and topographical attributes with a resolution of $1km^2$ served as environmental predictors. Combining the potential distribution of the vegetation unit with a MODIS time series analysis on actual land cover delivers a final map of current vegetation distribution.
As changes in land cover in the upper Okavango catchment in Angola will have direct influence on downstream ecosystems in neighboring Namibia and Botswana, vegetation mapping is an important step to create the base line data necessary for sustainable resource management. This study illustrates how macroecological modeling tools can help to overcome lacking information in regions with very limited ecological data.

P3 – Vegetation changes along a climatic gradient during a severe drought year in the El Niño region 1

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El Niño Southern Oscillation (ENSO) has profound effects on terrestrial, and especially arid ecosystems. Ecological effects of El Niño on terrestrial ecosystems have been investigated in detail, however studies on the impact of La Niña are rather sparse. We therefore investigated the plant composition along a precipitation gradient during a La Niña drought year in a hyper- to semi-arid environment in NW-Peru. Wesampled 50 randomly chosen plots (30 * 30 m) following the principal humidity gradient. We examined vegetation composition and soil parameters using NMDS and variation partitioning (RDA). Plant traits were assessed with a RLQ analysis. We found 48 vascular plant species (23 families). Species number varied between 0 and 17 per relevé (mean: 6). Species richness, reflecting the precipitation gradient, followed at first a hump-shaped pattern, before increasing linearly. NMDS distinguished three vegetation communities. Precipitation clearly was the main gradient and spatial variance characterized the second gradient. RLQ analysis identified succulence, spininess and hemicryptophytes relevant on the second axis. During this extremely dry year only specifically drought-adapted species blossomed. The NMDS ordination suggests that the precipitation amount of the vegetation period had to surpass at least 20 mm, in order to change species composition. When precipitation is the limiting factor for plant growth, soil variables only play a minor role in explaining the vegetation composition. This pattern might reverse under El Nino conditions, and the latter may be responsible for the occurrence of phanerophytes along the hyper-arid coast. Human impact also influences the vegetation composition, and will increase in the near future, endangering the last endemic dry forest formations.

P4 – Area prioritization and effectiveness evaluation of the conservation area networks for anurans in the Colombian Andes

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Global Amphibian Assessment highlighted Colombia as the country with the second highest number of amphibian species in the world and the most threatened species. However, none systematic area prioritization for selection of conservation area networks (CANs) considering anurofauna exists so far. We combined niche modeling of 155 species and systematic area prioritization of anurans from the Andean region of Colombia, with two objectives: 1) to evaluate the existing set of protected areas with respect to its performance in representing anuran species; and 2) to identify new priority areas into which the existing protected areas can be augmented. In a two-step protocol, maximum entropy niche modeling was used to project anuran species' potential geographic distributions. The predictions were used to evaluate the performance of the actual conservation areas network and prioritize areas with rarity and complementarity-based algorithms implemented in the ConsNet conservation planning software, which maximizes the representation of all species in minimal total area, using representation targets of 5% and 10%. Our results show that Colombian Andes´ anurofauna is poorly protected under the existing CAN. While, area prioritization results show that by targeting a minimal representation of 5% of the current total area suitable for each species, the gaps can be filled with a relatively modest (0.88%) increase in the current total area covered by the network. An increase of protected areas is especially needed along parts of the upper and middle part of the Magdalena River Basin and the Volcanic Massif and Antioquean Mountains of the Cordillera Central.

P5 – Global Scale Quantification of Bird Community Functional Diversity

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Urban environments now harbor the majority of the human population and are expanding faster than any other type of land cover. Associated with urbanization are ecological changes, including changes in species richness and composition. Although well documented in natural ecosystems, the consequences of these changes in urban environments have been largely neglected. Therefore, this project aims to explore quantitatively, for the first time, how changes in species richness and composition caused by urbanization affect functional diversity, the component of biodiversity that informs about the roles that organisms play in ecosystems. The project is based on a global literature review that compiles data from papers reporting avian assemblage structure at paired urban-rural sites and those only urban assemblage data. In the later case, information on the rural assemblage is obtained from compilations of regional species pools. To measure the effect of urbanization on avian functional diversity, we will apply quantitative functional diversity methodologies (FD, mean dissimilarity, Q and functional richness) to these assemblages. We predict that urbanization reduces functional diversity at global scales, due to homogenization of ecological communities and test the following specific hypotheses: a) at a large spatial scale urban development is associated with reduced functional diversity across multiple paired

urban and rural sites from across the globe; b) urbanization has a greater impact on functional diversity in urban areas that have little green space; at paired sites where the rural areas consists of natural habitat rather than agricultural land; and in geographically large urban areas.

P6 – Potential climate driven distribution changes of two closely related European toads

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Recent climate change is widely expected to affect the distribution of species. Species distribution modelling aims to estimate the potential direction and dimension of range changes by coupling climatic information with current distribution patterns. While it is generally accepted that the specific ecological requirements of a given species should be considered in distribution models, many studies use a generic approach to model building.

Here, we applied species distribution models considering terrestrial and aquatic habitat requirements of two European amphibian species: *Bufo calamita* and *Bufo viridis*. Future projections up to 2050 were driven by the HadCM3 climate model and the A2 emission scenario. Further, two dispersal scenarios were applied: no and unrestricted dispersal. Subsequently, influences on the shared distribution area of these two species were examined.

Modelling results project declines of distribution area for *B. calamita* on the Iberian Peninsula and at the eastern range border. Under the assumption of unrestricted dispersal new potential distribution areas can be expected in Northeast-Europe. For *B. viridis* nearly no declines in distribution area are projected. Considering unrestricted dispersal, new potential area in the north and northeast of Europe is projected facilitating northward range expansions. The overlapping area of both species in Germany seems to remain stable with only few projected losses and gains.

Both species are protected by the EU Habitats Directive. *Bufo viridis* could benefit from climate change or be at least unaffected. In this case, additional adaptation strategies for conservation seem not to be necessary. In contrast, the projected changes for *B. calamita* indicate that the development of conservation strategies under changed environmental conditions is required.

Session 23 – Maintenance and promotion of biodiversity in man-made habitats

Chairs: Bruno Baur, Martin Dieterich

O1 – Effects of long-term trampling on the above-ground forest vegetation and soil seed bank at the base of limestone cliffs

Hans-Peter Rusterholz[1], Christine Verhoustraeten[1], Bruno Baur[1]

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Exposed limestone cliffs in central Europe harbour a highly diverse flora with many rare and endangered species. During the past few decades, there has been increasing recreational use of these cliffs, which has caused local environmental disturbances. Successful restoration strategies hinge on identifying critical limitations. We examined the composition of aboveground forest vegetation and density and species composition of seeds in the soil seed bank at the base of four limestone cliffs in mixed deciduous forests that are intensively disturbed by human trampling and at four undisturbed cliffs in the Jura Mountains in northwestern Switzerland. We found that total plant species richness of the above-ground vegetation was marginally lower at the base of disturbed cliffs than at the undisturbed cliffs. Furthermore, total plant cover was significantly decreased at the base of disturbed cliffs compared with undisturbed cliffs. Compared with undisturbed cliffs, total seed density was lower in disturbed cliffs. Human trampling also altered the species composition of seeds in the soil seed bank. Seeds of unintentionally introduced, stress-tolerant, and ruderal species dominated the soil seed bank at the base of disturbed cliffs. Our findings indicate that a restoration of degraded cliff bases from the existing soil seed bank would result in a substantial change of the original unique plant composition. Active seed transfer, or seed flux from adjacent undisturbed forest areas, is essential for restoration success.

O2 – Traditional wood pastures provide important habitat for woodpeckers in Transylvania, Romania

Ine Dorresteijn[1], Tibor Hartel[1], Jan Hanspach[1], Joern Fischer[1]

[1]Leuphana University Lüneburg, Lüneburg, DE

Wood-pastures used to be common grazing areas around Europe. They represent important cultural-natural heritage and support a high biodiversity. Although many wood-pastures have lost their function in western Europe, ancient wood-pastures are still commonly used in eastern Europe. However, they suffer from many threats such as abandonment and clearance. In this case study we assessed the importance of wood-pastures as habitat for woodpeckers in southern Transylvania, Romania. Woodpeckers are keystone species because they provide nesting habitat for secondary hollow nesters. However, they can be sensitive because they depend on old trees and dead wood – components which are common in traditional wood-pastures. Focusing on Southern Transylvania, we (1) compared the presence of the six most common woodpecker species in wood-pastures (n=28) with their presence in

forests (n=12) using playbacks; and (2) assessed whether their presence was related to tree density, tree species composition, tree diameters and landscape context. Despite woodpeckers being considered forest birds, we frequently found higher woodpecker richness, and higher rates of incidence of woodpeckers, including species protected under the EU Bird Directive, in wood-pastures than in the forest. Woodpecker richness was context dependent, responding to forest cover and the presence of large oak trees. Our results show that ancient, traditional wood-pastures with old and large trees provide important feeding habitat for woodpeckers. The potential of wood-pastures to support high woodpecker diversity could especially be important close to young forests and replanted forests where woodpecker diversity is generally lower.

O3 – Wood-pastures in Southern Transylvania, Romania: assessment and threats

Tibor Hartel[1]

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Wood-pastures are cultural and natural landscape elements of international importance. Virtually nothing is known about the status and distribution of wood-pastures in Eastern Europe. Here, I present a survey of wood-pastures in a historical rural landscape from the Saxon area of Transylvania, Romania. These wood-pastures were formed by Saxons through rearing the existing forests and grazing them with cattle and were historically managed as communal pastures. After 1989 a massive reduction of the cows occurred due to social, economic and institutional changes. This triggered the development of scrubs and the forest regeneration in wood-pastures. However, since 2007 farmers have the opportunity to access agri-environment payments and part of this they clean the pastures and wood-pastures from scrub and young trees and the number of sheep is increasing due to financial incentives. Within this study I surveyed 42 wood-pastures and measured the circumference of trees, recorded the type of livestock grazing and the degree of shrub encroachment.
The dominant tree species in the wood-pastures were Oak (*Quercus robur*, *Q. petraea*), with occasional occurrences of beach (*Fagus sylvatica*) and hornbeam (*Carpinus betulus*). Oaks with more than 300 cm trunk circumference were found in 17% of them and those having more than 400 cm may also be frequent in some wood-pastures. Sheep grazing occurs in 64% of wood pastures, while 19% are grazed with cows only and 17% are mixed with sheep (numerically dominant) and cow (their number is still reducing).
Wood-pastures in the Saxon area of Transylvania are dramatically threatened due to uncontrolled burning and cutting. The historical and present relationship between the rural societies and wood-pastures from Southern Transylvania represent a good system for a social-ecological type of framework to address how nature conservation issues are linked to social and economic changes in traditional rural landscapes of Eastern Europe.

O4 – Reintroduction of three endangered plant species into steppe-like grasslands in Thuringia - effects of source population and habitat type

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We investigate the possibility of reintroduction of three typical plant species of relict steppe grasslands in Thuringia – *Astragalus exscapus, Pulsatilla pratensis* subsp. *nigricans* and *Scorzonera purpurea* – and ask which characteristics of the source populations (e.g. population size) and of the target areas have an effect on the success of reintroduction. Seeds of each species were collected in up to twenty natural populations. In spring 2010 and autumn 2011, about 1000 (*S. p.*, *P. p.*) and 2000 (*A*. *e*.) juvenile plants were planted out in six to eight target areas. In each target area plants were planted into two different habitat types: dry (southern slope) and semi-dry (northern slope) grassland sites.
For *S. purpurea*, growth and survival were documented for the years 2010 and 2011, for the other two species monitoring has just begun in 2012. From the originally planted individuals of *S. purpurea*, 70 % survived until 2011, of which 43 % flowered. Rate of survival strongly differed between grassland sites. In three of the six target areas about 85 % of the plants survived. Progenies of *S. purpurea* from small source populations had smaller shoots but longer leaves than those from large populations. Plants from dry grasslands grew better but flowered less than those from semi-dry grasslands. Individuals of *S. purpurea* that were planted on southern slopes had more and longer shoots than those that were planted on northern slopes. Plants with the same original and target habitat had less leaves than plants whose original and target habitat differed from each other. A negative relationship between vegetation height and growth and survival of the reintroduced plants indicates strong competition by other plants. However there was a positive correlation between cover of vascular plants and flowering success of the already established plants. In general our preliminary shows that reintroductions can contribute to the conservation of the relict steppe flora.

O5 – Vascular plants as surrogates of butterfly and grasshopper diversity on Swiss alpine pastures

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Grassland habitats in the Swiss Alps have been shaped by human agricultural activities for hundreds of years. Because of current land use changes driven by socio-economical motivations the high biodiversity of these landscapes is decreasing. Although these habitats make up one third of the whole Swiss agricultural area, direct payments dedicated to support its management are very low. Current political instruments do not support efforts in the conservation of biodiversity in these areas. However, a vegetation-based approach as the one implemented in the lowland is under discussion. Surrogate taxa as indicators for the whole biodiversity are widely used in conservation biology, because professional data collection in the field is time consuming and expensive. This approach is mainly based on the assumption that different taxa have congruent distribution patterns. Available studies evaluating the surrogate value of vascular plant for other taxa yielded inconsistent results, and investigations in alpine habitats are rare. We investigated the extent to which vascular plants are adequate surrogates for butterfly and grasshopper diversity by examining the congruence of species richness and community similarity patterns in two highly heterogeneous subalpine pastures in the Swiss Alps. Results at the species richness level (Spearman's rank correlation) were highly variable depending on the study site and taxa regarded. At the community level (Procrustean analysis with Bray-Curtis similarity) instead, congruence between vascular plant and invertebrate taxa were satisfactory. We therefore recommend the use of community data instead of mere species richness, which do not takes species identity into account, in studies addressing surrogacy. We suggest that a vegetation-based approach aimed at the conservation of plant diversity can be expected to contribute to the conservation of butterflies and grasshoppers, at least in the subalpine grassland habitat.

O6 – Orthoptera as ecological indicators for succession in steppe grassland

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Understanding the effects of land-use on threatened ecosystems is of special relevance for nature conservation. The aim of our study was to use Orthoptera as ecological indicators for succession in Central European steppe grasslands.
Orthoptera showed a clear response to succession. Each successional stage harboured a unique assemblage. Species richness of habitat specialists was highest in the earliest seral stages. In contrast, density of all species peaked at the intermediate successional stage. Early successional stages are mostly likely to be preferred by specialized Orthoptera because they provide suitable oviposition sites (bare ground) and warm microclimatic conditions. The density peak in the mid-successional stage probably reflects a trade-off between favourable ambient temperatures for optimal development, sufficient food and shelter against predators. Although all successional stages of steppe grassland are relevant for conservation, early and mid-successional stages are the most important. Consequently, conservation management should aim at reintroduction of a traditional, low-intensive land use for abandoned steppe grasslands. As an optimal land use, we recommend traditional rough grazing with sheep and goats, which creates a heterogeneous habitat structure with bare ground, and avoids the accumulation of litter, favouring Orthoptera.

- Published as: Fartmann, T., Krämer, B., Stelzner, F. & D. Poniatowski (2012): Orthoptera as ecological indicators for succession in steppe grassland. *Ecological Indicators* 20: 337–344

O7 – Short-term effects of irrigation on the biodiversity of species-rich hay meadows

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The maintenance of traditional management practices is essential for the conservation of the biodiversity of semi-natural grasslands including species-rich hay meadows. In the canton Valais

(Switzerland), hay meadows were traditionally irrigated using open water channels. However, since the 1980s, this labour intensive irrigation technique has been increasingly replaced by sprinkler irrigation systems. We examined whether the different irrigation techniques (traditional vs. sprinkler) influence the local biodiversity of species-rich hay meadows in the Valais. We compared the diversity and composition of plant and gastropod species of eight traditionally irrigated meadows with those of eight sprinkler-irrigated meadows. We also assessed whether the species of either meadow type differed in single traits. Traditionally and sprinkler-irrigated meadows did not differ in the diversity and composition of plant and gastropod species. However, different irrigation techniques affected the leaf distribution and the onset of seed shedding. Our study shows that a change in the irrigation technique altered some aspects of biodiversity within a relatively short period of 8–18 years. It is expected that these differences will be more pronounced in the long-term resulting in local species extinction. We therefore recommend maintaining traditional meadow irrigation, because this technique constitutes an important factor for the conservation of the biodiversity of hay meadows in the Valais.

O8 – Effects of distance to grasslands and landscape heterogeneity on flower-visiting insects depend on taxa and ecological traits

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Semi-natural grasslands are known to provide pollinating insects to surrounding agricultural landscapes through spill-over effects. However, independent effects of surrounding landscape structure and distance to semi-natural grasslands is poorly known due to a general lack of studies conducted in replicated landscapes. We analysed the independent effect of increasing distance from semi-natural grasslands and decreasing landscape complexity on butterflies, bumblebees and hoverflies in Southern Sweden. In general, distance to semi-natural grasslands had much stronger effects on flower-visiting insect abundance and species richness as compared to surrounding landscape complexity. The species richness and abundance of bumblebees and butterfly habitat specialists decreased with increasing distance, whereas species richness and abundance of butterfly habitat generalists and hoverflies did not. The abundance of bumblebees with long colony cycle, small colony size and nesting above ground decreased with decreasing landscape complexity, whereas the species richness of these bumblebee trait groups increased through multiplicative effects of decreasing distance to semi-natural grasslands and increasing landscape complexity. We conclude that enhancing flower-visiting insect communities will be most effective if the evenly dispersed semi-natural grasslands are conserved throughout agricultural landscapes.

O9 – Explaining and predicting the distribution of High Nature Value (HNV) farmland in Germany

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Supporting and maintaining High Nature Value (HNV) farming has been a priority for EU rural development policy since 2005 and is highly relevant for biodiversity conservation in agricultural landscapes. Explaining and predicting the approximate distribution of HNV farmland in Germany facilitates distinctions between prime and marginal agricultural areas (high-input vs. low-input farming) and contributes to the spatial targeting of agri-environmental policy instruments.
We used an official dataset comprising the area and quality of HNV farmland in Germany originated from field surveys of 915 plots, measuring one square kilometre each. Plots were scattered all over Germany and the area of grassland, arable land and landscape elements with high nature conservation value was assessed using a standardised survey design. In order to identify the most important driving factors of HNV farmland and to predict its distribution in a spatially explicit way, we gathered GIS-data and derived more than 50 environmental and agricultural variables. We performed a principal component analysis to reduce the number of variables to orthogonal axes. These axes describe the main gradients in agri-environment space for Germany, which are (i) topography (slope, altitude), (ii) field management (fertilisation, crop yield), (iii) landscape structure (edge density, hedges), (iv) animal production (livestock units, maize) and (v) arable production (arable land, soil quality). Our model shows that a combination of environmental and agricultural axes explains the distribution of HNV farmland. Model predictions assist in identifying marginal agricultural areas (low-input farming) with high potential for farmland biodiversity in Germany.

O10 – Biotic homogenization of Central European urban floras

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Spread of alien species may result increasing similarity between biotas of different areas /e.g. biotic homogenization). We examined whether the flora of Central European cities is becoming homogenized because of the spread of alien species, whether the contribution of aliens to homogenization depends on residence time, and whether habitats under more intense human pressure are more homogenized. Using floristic composition data from a standardized sample of 1-ha plots located in seven habitat types in 32 cities in Central Europe, Belgium and the Netherlands, we compared homogenization effects of archaeophytes (pre-AD 1500 aliens) and neophytes (post-AD 1500 aliens). We found that archaeophytes contributed to homogenization and neophytes to differentiation of floras among cities, but generally the spread of alien species caused differentiation. Differentiation was low in the most disturbed urban habitats, but was strongest in moderately disturbed habitats. We conclude that biotic homogenization depends on alien plants' residence time. Aliens introduced within the past five centuries are often rare, not yet having achieved their potential range; they therefore increase floristic differentiation. Conversely, species introduced more than five centuries ago have had sufficient time to disperse into most suitable habitats, and consequently contribute to homogenization. Although invasions may

therefore initially increase biodiversity, they could ultimately lead to homogenization. These processes are faster and stronger in more disturbed habitats.

O11 – Potential for native grassland species in novel urban ecosystems

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Enormous wasteland sites evolve in shrinking cities – areas that can be assessed as novel urban ecosystems. These are often characterised by highly altered soil conditions and new species combinations, which are readily dominated by non-native species.
We hypothesise that these areas have great potential for developing extensively managed meadows when restoration strategies aim at involving specific site conditions such as high stone content in the soil and spontaneous vegetation.
In a 5-year *in situ* project we therefore assessed whether disused urban areas can serve as habitat for grassland species by testing different restoration strategies (dry hay transfer, sowing of regional seed mixtures, sowing and an additional mycorrhizal inoculation). We compared plant species richness and the establishment of target species for the different treatments and analysed the included proportions of native and non-native species.
The results up to the fourth year revealed highest total and target species richness in plots where regional seed mixtures were sown or where sowing was combined with a mycorrhizal inoculation. Hereby, target species numbers additionally increased from the second to the third year and remained staple in the fourth year. Surprisingly, the time series showed high numbers and proportions of native species, partially up to 90% within all plots.
Comparing the results with this year's upcoming data will shed light on restoration success after 5 years. This allows further discussing the potential of developing such novel meadows in urban settings both as habitat for rare grassland species and as a low-cost greening and management strategy.

O12 – The role of an abandoned railway bridge in connecting urban habitats

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Railway edges and embankments facilitate migration of plants and animals. In urban areas, railway embankments connect plant and animal communities by providing routes of dispersal through inhospitable city environments. A recent study revealed that the presence of railway overpasses generally reduced ecological connectivity in urban areas (Penone et al. 2012, Biol. Cons. 148: 126–133). The construction of wildlife crossing structures (green bridges, culverts, pipes) is a means to mitigate barriers to animal movement. We examined whether a set-aside railway bridge crossing a road with high traffic density near Basel (Switzerland) can serve as green bridge to connect the embankments. We installed a drift fence in the middle of an abandoned 32-m long, single track railway bridge (iron-steel construction with a simple gravel bed) to capture the non-flying animals that crossed the bridge from either side. The traps were emptied twice daily (early in the morning and in the evening). Captured vertebrates were tagged and released on the opposite side of the bridge. Invertebrates were collected for later species determination. During the 275-day study more than 1500 animals were trapped on the bridge: small mammals (2 species), reptiles (1 sp.), amphibians (2 sp.), non-flying insects (52 sp.), diplopods (4 sp.), spiders (39 sp.), isopods (5 sp.) and gastropods (6 sp.). For many species, the individuals trapped on the bridge were on migration (e.g. frogs and toads on their way to hibernation sites). For other species the gravel bed and adjacent vegetation constitute their habitat but also serve as dispersal corridor. There were distinct interspecies differences in the daytime and season when the bridge was crossed. Almost 65% of the animals were trapped in the night. This study demonstrates that an abandoned railway bridge can serve as green bridge in an urban environment.

P1 – The effects of biodiversity and landuse on the water balance of a temperate grassland

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Agricultural grasslands are amongst the most species-rich ecosystems in Europe. In the last decades, land-use intensification led to changes in structure and plant diversity in those habitats. While much research focused on the impact of land-use changes on floral biodiversity little is known about the response of important ecosystem functions (e.g., water and nutrient cycling).

To gain insight into this field of study, we established a three-factorial biodiversity experiment on an existing temperate grassland in the Solling Mountains, Germany. The applied factors were sward diversity, cutting frequency and fertilization regime. The site was devided into 72 plots (three diversity treatments × two cutting frequencies × two N levels × six replicates), where data was collected in the growing seasons 2010 and 2011 from May until November. Evapotranspiration and drainage were measured by employing 48 small weighable lysimeters containing undisturbed soil and vegetation, which were weighed every two to three weeks. Further data was collected by measuring above and belowground biomass, plant diversity, water use efficiency, infiltration, dry biomass and climatic factors such as precipitation, photosynthetic active radiation (PAR), temperature and other climatic factors.

With our approach, we wanted to answer questions such as which effect has a loss in species richness for the water use of the sward, whether there is an influence of biodiversity on the amount of infiltration and groundwater charge and whether there is a stronger influence by species richness or by grassland and/or fertilizer use.

Preliminary results show that fertilization led to increased evapotranspiration and decreased infiltration values, while cutting frequency influenced the evapotranspiration. The combination of fertilization and cutting frequency has a strong effect on the water balance. However the diversity level (monocotyl, dicotyl, control) had no significant impact on the water cycle.

P2 – Bear activity in traditional woodpastures in southern Transylvania, Romania

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Romania harbours the largest remaining populations of the brown bear (URSUS ARCTOS) in Europe. Bear activity in Romania is not restricted to forest, but bears are frequently encountered in cultural landscapes, such as the traditional woodpastures. Woodpastures are still common throughout Transylvania. Many woodpastures contain anthills, and ant larvae are a frequently used source of protein for bears. However, woodpastures are increasingly threatened by clearance or abandonment, with unknown consequences for native species such as the brown bear. In this case study, we assessed the occurrence and distribution of bears in different kinds of woodpastures. Specifically, we assessed how bear activity differed (1) between woodpastures occurring in different landscape contexts; (2) between different locations within a given wood pasture; and (3) in relation to the vegetation structure of wood pastures.

We surveyed 150 transects (400m) in 40 woodpastures in southern Transylvania, which spanned a gradient of surrounding forest cover. Transects were placed in different parts of the woodpastures, including along the forest edge, in open areas, and in areas with dense shrubs. The rate of incidence of bear activity was assessed via counting both intact and destroyed anthills. Data were analyzed using generalized linear modeling.

We found that bear activity increased with proximity to large forest patches. However, no clear patterns were apparent with respect to the position of transects within a given woodpasture, or with respect to the density of shrubs. This is because anthill occurrence varied in relation to these variables.

Our findings suggest that despite common bear activity in woodpastures, bears are still primarily linked to their primary habitat, namely forest. The possible consequences of woodpasture abandonment (and hence shrub invasion) on bear distribution is difficult to predict. However, it appears certain that with more shrub and forest invasion, the amount of anthills in woodpastures will decrease, leading to the loss of a potentially important source of food for bears.

P3 – Bird-stand age relationship in natural forests, larch and Todo fir plantations

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It is suggested that early successional species, which use clear-cut area as habitats, are decreasing due to decrease of grassland and forestry recession in Japan. On the other hand, disorganized logging results in decrease of mid-to-late successional species which use developed forests. Forest plantations are now increasing in the world and harbor nontrivial biota in them. Therefore, to conserve bird diversity in forested landscapes, it is necessary to clarify the relationship between stand age and bird diversity in both natural and plantation forests. Here, we examined the effects of stand age on abundance of early-successional species and mid-to-late successional species in three major forest types in Hokkaido, Japan.

We surveyed breeding birds in young to old Japanese larch (*Larix kaempferi*) plantations, Todo fir (*Abies sachalinensis*) plantations and natural broad-leaved forests using a line-transect method (range of stand age: 1-150). We used generalized linear mixed model, indicator species analysis (INSPAN), and segmented regression to analyse bird abundance data. Results suggested that 1) Japanese larch and Todo fir plantations younger than 10 years old were habitats for early successional species, 2) abundance of mid-to-late successional species was higher in older stands regardless of forest types and 3) appropriate plantation management could contribute to bird diversity in a forested landscape.

P4 – Characterization and diversity of annual dry grasslands in the South Aegean (Greece)

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Annual dry grasslands of the orders *Tuberarietalia guttatae* and *Trachynietalia distachyae* are widespread vegetation types in the Mediterranean but only few publications concerning their ecology, diversity and syntaxonomy are available. This poster presents preliminary results of a field study on annual dry grasslands on the island of Crete, Greece. The study is part of a broader project with partners in several countries, towards a phytosociological survey of annual dry grasslands in Mediterranean Europe. In spring 2012 we collected data from over 160 plots throughout Crete covering a wide spectrum of vegetation dominated by therophytes. We included relevés of non-ruderal vegetation sampled on all kinds of available substrates. We collected data on vascular plant species composition, physical parameters and edaphic conditions following the FAO Guidelines for soil description, supplemented by data from soil lab analyses such as C/N ratio, carbonate content and pH values. The diversity analysis revealed very high αdiversity and considerable β diversity along an altitudinal gradient. While the project elaboration is currently in progress, preliminary results, as visualized by ordination diagrams and synoptic vegetation tables, suggest reticulate syntaxonomy and close correlation of species composition with soil factors and the mesoclimatic situation.
This study is the first approach to describe by modern methods the diverse annual vegetation of Crete. A survey on larger scale will be compiled as a synthesis of relevés from all over the Mediterranean. We welcome contributors!

P5 – Management effects in grasslands on functional arthropod diversity

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Meadows, pastures or a combination of both are the main management types in German grasslands and have been adjusted to the biotic and abiotic characteristics of different regions.
We expect more extensive management practices to support taxonomical as well as functional diversity of arthropods better than intensive management, despite regional differences.
Arthropods were collected on differently managed grasslands in three regions of Germany from 2008 to 2011. Species from 5 taxonomic groups (Araneae, Auchenorrhyncha, Heteroptera, Coleoptera and Orthoptera) were identified by experts to species level. Functional diversity was evaluated based on traits which were available for all 5 groups (including trophic guild, dispersal ability, stratum and body

size).The overall and regionally specific effects of management intensity, described by a land-use-index, on overall functional diversity and on single traits were evaluated with linear mixed effect models. Additionally, we analyzed effects of single management components (grazer, number of cuts, fertilization) on arthropod functional diversity.

Although general effects of land use intensity were found on dispersal ability (positive) and body size (negative), regional effects were stronger on other functional traits (e.g. trophic level). This would argue for adapting national conservation strategies to regional characteristics in order to preserve high functional diversity.

P6 – To be or not to be - *Daucus carota* from non-indigenous provenances

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The National Strategy on Biological Diversity aims at conserving ecosystems, species and genotypes. As result, in landscape restoration projects (e.g. along roadsides and on ecological compensation areas), the use of native speciesis compulsory. However, the provenances of the seeds is most often non-indigenous, as prizes from indigenous seed provenances are up to 10-fold higher and seed availability is still limited. The use of non-indigenous seeds is common, even the effects of foreign genotypes upon the ecologically adapted native flora are still unknown. Hybridization and introgression between non-native and indigenous provenances can reduce species' fitness and function as an effective driver for invasions below the species level. This can either lead to the homogenization or extinction of regional gene pools which results in loss of local adaptations, or locally adapted genotypes thrive more successfully so foreign genotypes diminish after certain periods of time.

We here investigate the effects of non-indigenous *Daucus carota* provenances upon native gene pools after defined periods of time. For this 10 indigenous and 10 non-indigenous populations are being investigated. The genetic diversity is being analyzed by using nuclear microsatellite markers which are compared to fitness related parameters. The results will provide scientific evidence for the use of indigenous seeds in landscape restoration as proclaimed by the Federal Nature Conservation Act (01.03.2010) which will come into effect in 2020.

P7 – Designing a large-scale experiment concerning the restoration of pine monocultures

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Resulting from a historically intensive timber production, vast forest areas in Germany and Central Europe are dominated by even-aged pine monocultures, including a large portion of the natural heritage forests administered by the Deutsche Bundesstiftung Umwelt (DBU). Due to climatic changes and heightened demands regarding the provision of forest ecosystem services, particularly even-aged monocultures are associated with increasing risks, resulting in an amplification of forest management

uncertainties. Many forest owners therefore strategically aim for a higher degree of naturalness to improve forest stability and elasticity.
However, this issue has not yet been the subject of systematic scientific investigations in the respective region. The present project will design for a large-scale experiment in pine monocultures documenting the long-term effects of different restoration measures. The initiation and spatial arrangement of the restoration measures must 1) be spatially variable, 2) accommodate stochastic natural processes, and 3) be open with respect to the final outcome. In this context, the DBU offers several thousand hectares of potential research sites.
The project is structured into three work packages:
(1) *Literature review, study visits and analysis of existing large-scale forest ecology and restoration experiments*; resulting in a methodological overview and the subsequent definition of site selection criteria.
(2) *Compilation of existing spatial data and on-site evaluation of site suitability*; where suitable field sites are pre-selected based on available data and maps.
(3) *Final concept for a large-scale restoration experiment*; containing a site-specific study design, a conceptual design of initial and follow-up inventories and a supporting scientific programme.

P8 – Effects of patch size and distance to the urban edge on vascular plant diversity

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Cities are known to be home to numerous vascular plants and may play an important role in the conservation of plant diversity. In order to develop the relevance of open space in cities for biodiversity conservation it is necessary to understand patterns of plant diversity in cities. Aim of this study was to test for the effect of the size of an open patch and its distance to the urban edge on species numbers of all occurring vascular plants as well as a subset of established native species. In particular the following hypotheses were tested in Hannover, Germany.
Large open patches show higher species numbers than smaller ones.
Open patches close to the urban edge show higher species numbers than patches closer to the center.
We investigated a set of 32 open patches identified by a stratified random selection taking into account patch size and distance to the urban edge. Patch size varied from 0.7 ha to 72.3 ha, distance from the center of a patch to the urban edge varied from 190 m to 2872 m. A survey of all occurring vascular plants (self-established as well as planted) was conducted from June until August 2011 and March until May 2012. A Pearson's Correlation was conducted to test the hypotheses.
The number of all occurring plant species as well as the number of established native species is not correlated to the distance to the urban edge, while both are positively and statistically significantly correlated to the size of patches. These results suggest that the size of open patches in cities is a relevant factor determining vascular plant species diversity. Therefore, cities planners should focus on restoration and establishment of large open patches. The distance of a patch to the urban edge seems to be of minor relevance for overall species number. However, the distance of an open space to the urban edge may still be relevant for the occurrence of certain species.

P9 – Hydrochory processes along an urban-rural gradient at the river Wandse in Hamburg

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Rivers play an important role as linear landscape axes in habitat corridor systems. They serve as habitat and dispersal corridors for both animals and plants, which are of particular importance in anthropogenically altered landscapes. Cities can be generally characterized by a high degree of soil sealing and anthropogenic disturbance, in addition to modified climatic conditions and nutrient availability. Furthermore, urban rivers are more or less heavily affected by water management structures.

The aim of this study is to analyze the composition and diversity of propagules of vascular plant species transported by the river Wandse along an urban-rural gradient in the city of Hamburg and to examine whether the river could function as a dispersal corridor for vascular plants.

At three sites along an urban-rural gradient aquatic seed traps were placed in the river for one week per month from October 2011 till March 2012 and the water velocity at the three sites was measured. The samples were dried and sieved before seed determination with a binocular. In addition, vegetation composition of the three sites was recorded in order to obtain comparisons between vegetation and the propagule communities and estimates about dispersal distances.

Preliminary results show that more than 20.000 propagules of vascular plants from 94 taxa were captured by nine aquatic seed traps in two month. Most propagules and taxa were trapped at the suburban site followed by the urban site. At the rural site, only few propagules and taxa were found probably due to the low velocity. 70% of the 20 most common species trapped were woody plants.

Session 24 – Marine ecology

Chairs: Ulrich Sommer

O1 – The Baltic Sea spring phytoplankton bloom in a changing climate: an experimental approach

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The response of the Baltic Sea spring bloom was studied in mesocosm experiments, where temperatures were elevated up to 6°C above the present-day sea surface temperature of the spring bloom season. Four of the seven experiments were carried out at different light levels (32 – 202 Wh m^{-2} at the start of the experiments) in the different experimental years. In one further experiment, the factors light and temperature were crossed, and in one experiment the factors density of overwintering zooplankton and temperature were crossed. Overall, there was a slight temporal acceleration of the phytoplankton spring bloom, a decline of peak biomass and a decline of mean cell size with warming. The temperature influence on phytoplankton bloom timing, biomass and size structure were qualitatively highly robust across experiments. The dependence of timing, biomass, and size structure on initial conditions was tested by multiple regression analysis of the y-temperature regressions with the candidate independent variables initial light, initial phytoplankton biomass, initial microzooplankton biomass, and initial mesozooplankton (=copepod) biomass. The bloom timing predicted for mean temperatures (5.28 °C) depended on light. The peak biomass showed a strong positive dependence on light and a weaker negative dependence on initial copepod density. Mean phytoplankton cell size predicted for the mean temperature responded positively to light and negatively to copepod density. The anticipated mismatch between phytoplankton supply and food demand by newly hatched copepod nauplii occurred only under the combination of low light and warm temperatures.

O2 – Effects of climate warming on marine pelagic biodiversity and productivity

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Globally rising sea surface temperatures are predicted to strengthen water column stratification, reducing nutrient delivery to marine phytoplankton in the upper water layer. In parallel, increased temperatures have been found to intensify heterotrophic metabolic processes, leading to the stronger top-down control of phytoplankton consumers. Both nutrient limitation and increased grazing pressure reduce phytoplankton biomass and alter producer diversity. To examine the effects of sea surface warming, changed nutrient supply and grazing pressure on marine phytoplankton, we conducted indoor mesocosms experiments with natural marine pelagic community. A metaanalysis of the experiments conducted in our laboratory since 2005 indicated that warming directly affected primary productivity. Furthermore, warming strengthened top-down control, and thereby intensified the negative impact of

nutrient limitation on phytoplankton biomass. Temperature did not directly affect phytoplankton diversity, but indirectly acted on phytoplankton community composition and dominance due to changes in consumer pressure. This study provides new insight of possible changes in biodiversity in pelagic food web and emphasizes the importance of indirect temperature effects and producer-consumer interactions for understanding the responses of aquatic ecosystems to predicted climate change.

O3 – Multi-level oscillating trophodynamic control causes regime shifts in large marine ecosystem

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Changes in trophodynamic control from predominantly bottom-up (resource-driven) to top-down (consumer-driven) have been suggested as a mechanism causing sudden changes in the structure and functioning of foodwebs, so called ecosystem regime shifts. Trophic cascades represent top-down controls and conspicuous indirect effects over two or more links distant from the initial one. They are the most pronounced phenomenon related to changes in trophodynamic control and have been shown for multiple marine ecosystems. Fewer studies show oscillations between bottom-up and top-down control and do usually not consider interactions between all trophic levels. Here we provide evidence for oscillating trophodynamic controls over multiple trophic levels in the North Sea, one of the most productive ecosystems in the world ocean. We used a unique data set covering > 4 decades (1963 – 2007) and four trophic levels, i.e. phyto-, zooplankton, planktivorous and piscivorous fish. Moving correlation analyses revealed the alternating changes in control between trophic levels to strikingly coincide with major ecosystem regime shifts documented before. We further demonstrate by Generalized Additive Modelling (GAM) that oscillations in controls and hence ecosystem regime shifts are caused by complex interactions between climate variability and fisheries overexploitation.

O4 – Effects of initial community composition and pCO_2 on the functioning of natural phytoplankton communities

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Since industrial revolution rapid increase of atmospheric pCO_2 and consequent ocean acidification as well as unprecedented rates of biodiversity loss are major threats to marine ecosystems. Many experimental studies have shown significant effects of either increased CO_2 concentrations or biodiversity changes on individual physiological performance and ecosystem functioning. Major phytoplankton groups, in particular coccolithophores are known to be negatively affected by increasing CO_2 concentrations whereas diatoms might benefit from ocean acidification. Biodiversity loss and changes in community composition in turn have been shown to significantly alter ecosystem functioning

such as build up of biomass and nutrient cycling. However, it remains largely unknown how important each of the factors is when acting together. In a study on Terceira Island (Azores) using natural phytoplankton communities we set out to test the effect strengths of varying initial community composition and CO_2 concentrations on community functioning at bloom peak. Results suggest that both factors significantly contribute to the regulation of total biomass. First analyses show that depending on the initial community structure the functioning of the community responded differently to changes in pCO_2. This highlights the importance taking the consequences of community composition and resulting biotic interactions into account when assessing the impacts of climate change.

O5 – You eat what you need: food quality and trophic interactions in planktonic food webs

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Mesozooplankters and microzooplankters are often exposed to variations of food quality and quantity in their natural habitat, hence they must have acquired means to handle these fluctuations. Both metazoan and protozoan grazers regulate their body nutrient composition, which means that they are able to buffer nutrient imbalances between their demand and the supply by their prey. These homeostatic regulations can occur post-ingestion, but also several pre-ingestion mechanisms are known, and, when experiencing an unbalanced food supply, grazers may feed selectively for food quality differences to obtain a balanced diet. I showed that naupliar and copepodite stages of the copepod *Acartia tonsa* and the dinoflagellate species *Oxyrrhis marina* selects for prey items based on food quality differences. Further, I evidenced that selective removal of nutrient-rich cells as well as selective retention of nutrient by herbivores affect substantially nutrient cycles.

Session 25 – Molecular ecology

Chairs: Walter Durka, Thorsten Aßmann, Stefan G. Michalski

O1 – The biogeography of population differentiations in a radiating genus of the Canary Islands: Spatial or ecological drivers?

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Population differentiation may be a first step towards divergence and potential speciation. The Crassulacean genus *Aeonium* Webb & Berthel on the Canaries archipelago is a popular example for rapid species radiation on islands and therefore serves well to study processes of micro-evolution among closely related species and different islands. Due to a great and rapidly evolved diversity of distinct species, ecological niches, morphological forms and ecophysiological characteristics, as well as clear intrageneric lineages with vicariant distributions over partially very young islands, recent speciation and ongoing evolutionary processes can be assumed. Nevertheless, population genetic analyses of these interesting taxa to track this processes and to identify the spatial and/or ecological drivers of population differentiation have yet not been made in a sufficient manner.
Considering phylogenetic and biogeographical relationships, we selected three ecologically different single island endemic *Aeonium* species of La Palma, Tenerife and El Hierro and one variety distributed across two of these islands to reveal and compare population structures, potential evolutionary relevant differentiations and gene flow barriers. According to the strong topographical and ecological heterogeneity and steep gradients of these geologically young islands we hypothesize distinct intraspecific genetic patterns according to these structures over different geographical scales and differences among our study species.
From each taxon DNA-samples comprehensively were taken throughout the respective distribution range and DNA fingerprinting data were collected by analysing 9 ISSR (Inter Simple Sequence Repeats) markers, respectively. Population genetic analyses combined with GIS studies are carried out to detect geographically and ecologically conditioned population differentiations in order to investigate biogeographical patterns and evolutionary processes within these island endemics.

O2 – Scale dependent population genetic analysis in the heterocarpic annual *Catananche lutea* L. (Asteraceae)

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We here test the effects of habitat fragmentation upon genetic structure of a heterocarpic model species within a fragmented agro-ecosystem at different spatial scales. We evaluate if determinants (e.g. position along a precipitation gradient, patch area, patch isolation, geographic distance) affect genetic structure of our model species.
For this, fragmented populations of the annual Asteraceae species *Catananche lutea* L. have been investigated in an agro-ecosystem in the Southern Judea Lowland, Israel, within a desert–Mediterranean transition zone. Here, since the mid 1950s, intensive reclamation took place, which has reshaped the landscape to its current mosaic of scattered patches of natural vegetation, where insulated bedrocks or unconsolidated rocks appear in the basal subsoil, in a landscape which is predominately characterised by agriculture. Species, with formerly connected distribution ranges, now have restricted gene flow among populations with isolating effects upon population structure. We tested the effects of habitat fragmentation, precipitation and populations' isolation upon genetic structure (AFLP).
Our analysis revealed an intermediate level of intra-population genetic diversity across the study-site with a reduced genetic diversity on smaller scales. We found isolation by distance to be effective and detected a high level of genetic differentiation among populations but genetic structure did not reflect spatial patterns. Population genetic diversity was neither correlated to the position along the precipitation gradient, nor to different seed types or other plant fitness variables.

O3 – Unraveling the role of landscape elements for genetic structuring in a semi-dry grassland plant in the Swiss Alps

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Semi-dry grasslands are of high conservation value due to its rich biodiversity. Yet, their total area declined over the past decades following land use abandonment or intensification. Semi-dry grasslands are highly fragmented across the lowlands of Switzerland, while partly larger areas in the Central Alps are still present from montane to alpine levels. To improve efficiency of land-use planning in the mountainous landscape with respect to successful protection of semi-dry grassland areas, it is important to understand which factors determine genetic structuring within semi-dry grassland species. Gene flow in this habitat might be affected by a number of variables, including landscape elements and the altitudinal gradient.
In our study we apply AFLP markers to characterize the genetic structuring in the grassland plant *Trifolium montanum*. We sampled 24 individuals at each of 62 sampling sites (650 to 2080 m a.s.l.) within two Alpine valleys (10 x 10 km each) in Graubünden (South-Eastern Switzerland). To characterize population density at each site, all flowering and non-flowering individuals were counted in ten 50x50cm quadrats. We will apply GIS-based analyses to test for the effects of different landscape

elements (with a special focus on forests) and terrain particularly on current population differentiation and individual density using land cover data and a high resolution digital elevation model.
We assume that forest areas might function as barriers for pollinators in semi-dry grasslands, and due to the strong interlock of grassland and forest in mountainous landscapes, forests might have a strong influence on gene flow among grassland patches. If this would be true, forest elements should be considered in landscape planning processes with particular care.

O4 – Range expansion of a selfing polyploid plant despite widespread genetic uniformity

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Ongoing and previous range expansions have a strong influence on population genetic structure of plants. In turn, genetic variation in the new range may affect the population dynamics and the expansion process. The annual *Ceratocapnos claviculata* (Fumariaceae) expanded its atlantic European range in the last decades towards north and east. We investigated patterns of genetic diversity across the native range to assess current population structure and phylogeographic patterns. We then tested whether genetic diversity is reduced in the neophytic range and tried to identify source regions of the expansion.
Genetic diversity at population level was very low (mean H_e = 0.004) and two multilocus genotypes dominated large parts of the new range. Population differentiation was strong (F_{ST} = 0.812). These results and a low pollen/ovule ratio are consistent with an autogamous breeding system. Genetic variation decreased from the native to the neophytic range. Within the native range, H_e decreased towards northeast, whereas population size increased. According to the Bayesian cluster analysis, the putative source regions of the neophytic range are situated in NW Germany and adjacent regions.
*C. claviculata*shows a cline of genetic variation due to postglacial recolonization from putative Pleistocene refugia in SW Europe. Nevertheless, the species expanded successfully during the past 40 years to S Sweden and NE Germany where it occurs as an opportunistic neophyte. Recent expansion was mainly human-mediated by single long distance diaspore transport and facilitated by habitat modification.

O5 – Genetic markers and climate niche models indicate glacial refugia for the flightless ground beetle *Carabus sylvestris* north of the Alps

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*Carabus sylvestris*is is a flightless ground beetle species which inhabits montane and alpine habitats in central and eastern European mountain ranges up to an altitude of 3000m. The species has a disjunct distribution with populations confined to the different mountain ranges.
Genetic studies from 27 populations collected across the distribution range reveal clear and congruent differentiation patterns in both mtDNA gene sequences (CO1 and ND5) and allozymes. Specimens from the Carpathian Mountains show the strongest differentiation from all other populations. Within the remaining populations, those from the Alps are strongly differentiated from populations inhabiting central European mountain ranges. These findings suggest the existence of glacial refugia north of the Alps for this cold-adapted species.
Using species distribution modelling techniques, we identified the climatically suitable areas for *C. sylvestris* and reconstructed its potential distribution range during the last glacial maximum (21,000 y bp). Some mountain ranges north of the Alps were included in the potential distribution. These areas are (at least partly) still colonized by the species and show a higher genetic diversity, especially in comparison to presumably recolonized areas.
The postulation of northern glacial refuge areas for *C. sylvestris* coincides with conclusions from other contemporary studies on cold-adapted species (e.g. some tree species). These new results indicate that the diversity of species able to survive the last glacial period in central European refugia is higher than previously postulated.

O6 – Linking phylogeography and global change biology: history and future of the cold-adapted ground beetle *Carabus irregularis*

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Species and genetic diversity in Europe were vastly shaped by contractions and expansions of glaciers and permafrost grounds during Quaternary climate cycles. However, not alone historical climate events but also current and future climate change can have a strong effect on diversity patterns. Using mitochondrial DNA analysis and species distribution modelling (SDM) we developed past and future distribution scenarios for the cold-adapted European ground beetle *Carabus irregularis*. For reconstructing historical processes, we studied two mitochondrial DNA loci - CO1 and ND5, the first also being suggested as a valuable barcoding marker in carabid beetles. Phylogenetic analyses reveal two major clades and five subclades within the study species, which are likely to have split long before last glacial periods and which do not correspond with the three taxonomic subspecies of *C. irregularis*. While SDMs infer a relatively widespread distribution and Central European glacial refugia (even north of the Alps) of *C. irregularis* during the last glacial maximum, they predict an immense habitat loss in the future. A declining habitat would be accompanied with an enormous loss of genetic diversity in the study species, since one major phylogenetic clade and two subclades are at high risk of extinction.

O7 – Excessive gene flow in a hybrid zone despite differences in male genitalia: A contribution to the lock and key hypothesis in insects

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One of the most general evolutionary trends in animals with internal fertilization is the rapid divergent evolution of male genitalia. The lock and key hypothesis, which postulates that the difference in male genitalia prevent species from hybridising, appears to be an effective mechanism in the genus *Carabus*. Allopatric taxa of *Carabus violaceus*, Linné 1758, show clear differences in male genitalia. This is especially true for *Carabus violaceus violaceus* and *C. v. purpurascens* which have a secondary contact zone in northern central Europe in the eastern lowlands of Lower Saxony. Morphological trait such as aedeagus and elytral sculpture, allozymes and a mtDNA marker (CO1) were employed to estimate the occurrence of gene flow and all of them show congruent patterns: Both taxa exhibit excessive gene flow despite significant differences in aedeagus features and all markers are independent from each other at least in the hybrid zone. The taxa have a geographically large hybrid zone supporting the assumption of introgressive hybridization. As Hardy-Weinberg-equilibrium is predominantly fulfilled there is no evidence for a selection pressure against hybrids. As a consequence, species delineation based on genital morphology is questioned, at least for the *Carabus* genus. Moreover, phylogenetic analysis revealed high pairwise sequence divergence between haplotypes clustering on three well supported clades. Sequence divergence suggests the separation of *C. violaceus* haplotypes during the transition between the Pliocene and the Pleistocene epochs.

P1 – Effects of different light environments on epigenetic variation in populations of *Viola elatior*

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Epigenetic information, such as DNA methylation, is 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 the contrasting habitat types and if there are potentially adaptive changes that are related to light availability. We therefore assessed the genetic and epigenetic variation of different meadow- and woodland-populations by using the methylation sensitive amplified polymorphism technique (MSAP). The results of this study are discussed in relation to the adaptive impact of epigenetic processes under environmental changes.

P2 – Investigating population size effects on substitution rates in European spring snails (*Bythinella* spp.)

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The molecular clock approach, that is, relating numbers of substitutions in nucleotide or amino acid sequences to divergence time of monophyletic taxa, has become a widely used, but also controversial tool in evolutionary biology. Especially the accuracy of molecular dating approaches is debated. In order to increase the accuracy, researchers aim at understanding the parameters affecting rate heterogeneity between and among lineages (e.g., body temperature and size, mode of reproduction, and effective population sizes). Though the theoretical affects of these parameters are well understood, practical studies so far failed to reveal significant correlations between tested parameters and substitution rates. However, all these studies utilized higher taxa (e.g., families or orders) as model groups that are likely affected by more than one parameter and thus adding noise to the data set. To reduce noise effects analyses should be performed by using samples from a comprehensive group with nearly identical genetic constitution, life history and habitat preferences. The cold-adapted European spring snail genus *Bythinella* is such a potential candidate taxon. In this study we investigate the effects of population size, habitat differences like altitude and local radon radiation on substitution rates. Based on preliminary analyses suggesting significant "geographical" effects, we currently use mitochondrial COI sequences from 1100 individuals collected throughout Europe to calculate population specific substitution rates, represented by phylogenetic tree branch lengths. We believe that understanding possible population effects on substitution rates will help to improve the molecular clock estimations. It might also help to establish external molecular clock-rates based on life history, ecological and population genetic traits.

Session 26 – Multitrophic interactions in agricultural landscapes

Chair: Christoph Scherber, Klaus Birkhofer

O1 – Land use affects grassland multidiversity

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Land use intensification is one of the major drivers reducing biodiversity but the responses of individual organismal groups vary. Previous studies have examined groups in isolation making generalisations and comparisons between systems difficult. Here we present a novel method for calculating the multidiversity of a system, analogous to multifunctionality, which measures the number of organismal groups in a community at high diversity. We test the effect of land use on multidiversity using data on around 50 groups of organisms measured in grasslands in a large project, the Biodiversity Exploratories. We show that multidiversity declines exponentially with increasing land use intensity before reaching an asymptote, which indicates that in systems with low land use even small increases in intensity, can have dramatic negative effects on biodiversity. Importantly, changing land use between years had positive effects on biodiversity and for the multidiversity of rare species, higher temporal variation in land use maintained higher multidiversity even in intensively managed grassland. Our integrative measure of multidiversity should facilitate biodiversity comparisons between different systems. Our results suggest that land managers need to conserve areas of low land use intensity to maintain a high diversity of a range of groups but also that temporal variation in land use can be a mechanism to maintain higher biodiversity even in intensively managed systems.

O2 – Soil ecosystem services in conventional and organic arable fields along a gradient of landscape complexity in Sweden

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Agricultural intensification negatively impacts soil ecosystem services, including carbon sequestration and food production. Organic farming is often thought to conserve ecosystem services for sustainable agriculture. Conventional farming is often assumed to deplete ecosystem services. Understanding how farming methods affect soil services is vital for improving agricultural sustainability. It is also important to understand how landscape complexity affects soil services at the field scale. We compared a range of soil ecosystem services within conventional and organic arable fields along a gradient of landscape complexity.
Soil samples were taken from nine conventional and seven organic barley fields, and six semi-natural grasslands, and analysed for organic carbon (OC), plant-available phosphorous (P), total nitrogen (TN), net nitrogen mineralisation rate (net N) and water holding capacity (WHC). Microbial biomass and community composition were determined by phospholipid fatty acids.

Landscape complexity had no effect on soil services. Conventional and organic fields did not differ in OC, TN, WHC, P or microbial biomass. Semi-natural grasslands had significantly higher OC, TN and WHC, but similar P. Net N was greater in organic than conventional fields. Microbial community composition differed between barley fields and grasslands, driven by OC. Grain yield from the organic fields was significantly lower than from conventional fields.
We found no differences between conventional and organic arable fields across a range of soil ecosystem services, while organic fields were less productive. Organic farmers applied manure fertilisers and repeatedly tilled soil to control weeds; conventional farmers applied inorganic fertilisers and sprayed herbicides. Repeated soil disturbance increases mineralisation rates and may explain why organic fields showed no increase in OC, TN or WHC. Attempts to develop sustainable agriculture should focus on actual soil management practices rather than the labels “conventional” and “organic”.

O3 – Impact of experimental fertilization on the trophic diversity of oribatid mite communities

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Soil fertilization especially with organic substances triggers complex effects on soil biota diversity and functional structure. Fertilization may act on soil biota directly by increasing the availability of biogenic elements or indirectly by changing plant diversity, litter and root biomass, and microbial community performance. The aim of this experiment was to assess consequences of soil fertilization on the trophic diversity of oribatid mites and changes in community composition. We hypothesized that an increasing availability of biogenic elements would lead to trophically more diverse oribatid communities. The study was conducted in 2009 in 36 grasslands of the three Biodiversity Exploratories. We established experimentally fertilized 6x6 m subplots in managed grasslands in April and October 2009 by adding 200 g per m^2 of a biological fertilizer. The respective control subplots were not experimentally fertilized. Experimentally fertilized fields had somewhat higher overall oribatid species diversity and abundance, but this pattern was not observed in all regions. Experimentally fertilized soils hosted a larger proportion of specialized microphytophagous species compared to control plots. The presence of additional biogenic elements resulted in a wider overall trophic spectrum of oribatid mite communities. Such positive effects on the trophic diversity of oribatids may potentially lead to the (i) formation of additional trophic cascades which involve a wider range of predaceous soil animals and (ii) rechanneling of nutrients in soil food-webs.

O4 – Flying and ground-dwelling natural enemies provide effective biological control of cereal aphids across landscapes

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The ecosystem service of biological control of pests by naturally occurring arthropod enemies may be affected by agricultural intensification of the arable landscape. The contribution to the biological control of aphids by for instance flying specialist and ground-dwelling generalist predators may therefore differ between heterogeneous and homogeneous arable landscapes.
We hypothesized that the exclusion of enemies will result in higher densities and population growth rates of aphids and that this effect will be greatest in heterogeneous landscapes, where more predators are likely to occur. We also hypothesized that flying specialist enemies will have a relatively higher impact in heterogeneous landscapes, whereas ground-dwelling generalistic enemies will have a relatively higher impact in homogeneous landscapes, depending on their different need of e.g. floral resources and overwintering sites.
We conducted exclusion experiments and measured cereal aphid densities and population growth in 8 conventional cereal fields in heterogeneous landscapes and 8 in homogeneous landscapes. We compared the effects of naturally occurring enemies in open control plots with plots where we either excluded ground-dwelling generalist enemies (mainly ground beetles, rove beetles and spiders), flying specialist (mainly parasitoids and ladybirds) or both enemy groups.
We found that both ground-dwelling and flying enemies are important for suppressing cereal aphids and that effects were additive. Contrary to our expectations, we did not find a difference in biological control potential by different enemy groups in different landscapes, nor was the overall suppression higher in heterogeneous landscapes.
We conclude that naturally occurring predators and parasitoids are able suppress cereal aphids in all landscapes and thereby reduce the need for insecticide applications.

O5 – Interactions between web-building spiders and prey: Effects of habitat complexity and management intensity

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In agricultural landscapes, management and habitat complexity simultaneously affect arthropod diversity and may further alter trophic interactions in food-webs. We analyzed the impact of management intensity and habitat complexity on communities of web-building spiders and their prey at 12 study sites by hand-collecting web owners and prey. The diversity of web-building spiders and prey orders was positively related to vegetation coverage and plant diversity at the study sites. Hemipteran prey (primarily aphids) was overrepresented in spider webs compared to expected numbers and the ratio between pest and beneficial prey items increased with increasing vegetation density. Agricultural management negatively affected prey diversity and altered the composition of spider and prey communities. Our results suggest that species rich plant communities with higher complexity and habitats with lower management intensity conserve arthropod diversity, while habitat complexity may additionally affect the contribution of web-building spiders to biological control. We therefore suggest that increasing habitat complexity in agricultural habitats (e.g. by reduced weed control or undersowing) may be an important measure for improving the contribution of web-building spiders to biological control, while at the same time conserving plant and animal diversity.

O6 – Predicting grassland herbivory in monocultures and mixtures based on plant functional traits

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Plants interact with herbivores via functional characteristics (traits). We asked which traits determine herbivory for a large pool of plant species interacting with natural invertebrate communities in classically managed grasslands. In a large grassland biodiversity experiment (The Jena Experiment, Germany), standing herbivore damage was measured along the plant diversity gradient (monocultures to 60 species mixtures) and in additional monocultures of all species. Functional traits (physiological, morphological, phenological and herbivore-related traits) were collected, from literature, trait databases and own measurements. Using the Random Forest method and multiple regressions a model was constructed predicting species specific herbivory rates in monoculture.
Seven of 42 different traits predicted herbivore damage in monocultures: leaf nitrogen and lignin concentration, number of coleopteran and hemipteran species potentially feeding on the plant, leaf lifespan, stem growth form and root architecture. The final model accounted for 63% of the variation in herbivore damage. Very different traits were selected, thus a variety of plant characteristics, including root traits, are important when assessing folivory by a diverse community of herbivores. In a second step, the model was applied to mixed species communities based on abundance weighted traits averaged for the communities. The model did not scale up and explained only 7% of the variation in measured herbivore damage. Predictions were consistently lower than observed values. A second model estimating new partial slopes in mixtures for the same set of traits, thus relaxing assumptions and allowing for changed importance of the traits in mixtures, explained 25% of variation, which was still considerably worse than in monocultures.
Models based on community weighted traits assume no interactions between plant species in mixtures and that mechanisms linking traits and response variable are unaltered in communities. They have been successfully used to predict plant physiological processes, e.g. biomass production. The low performance of such a model in predicting community herbivory indicates a high degree of non-additive effects in the interaction between the herbivore and food plant communities.

Session 27 – Pollination ecology

Chairs: Carolin Mayer, Tim Diekötter, Annette Kolb, Claire Brittain

O1 – Endangered synchrony: Phenology and interaction patterns of plants and pollinators along an altitudinal gradient

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While global climate change generally advances the timing of phenological events and extends the length of the season in temperate regions of the world, there is considerable variation in the magnitude of phenophase shifts experienced by different species. Recently, this fact has raised concerns about the possibility of phenological desynchronisation of interacting species, particularly in the case of mutually dependent species such as plants and pollinators. In this study, we took advantage of the natural variation of climatic conditions along an altitudinal gradient in the Alps to examine the changes in phenology and interaction patterns of plant and pollinator communities with changing temperature and season length. Abundances and interactions of flowering plants and flower visitors were sampled weekly at six altitudinal levels over the course of a season. Our main hypothesis was that the negative effect of a phenological mismatch on pollinator fitness should be most severe for species with a strong preference for the respective plant species. Therefore, we expected to find a positive relationship between the strength of the preference of a pollinator species for a certain plant species and the degree of synchrony of its phenophase with that of the plant.
Our preliminary results suggest that indeed a positive relationship exists between link temperature (a measure of the strength of preference for a plant) and the degree of synchrony of the species pair's phenophases. This result implies that some pollinator species do not only preferentially visit a particular plant when it is available, but also synchronize their phenophase with that of the plant. Thus, it is likely that phenological decoupling induced by rapid climate change will have a negative effect on survival and reproduction of these flower visitors.

O2 – Pollinating seed predator, *Hadena ectypa*, of *Silene stellata*: Mutualism or parasitism when specialized host plants are isolated?

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The ability of small plant populations to attract pollinators to successfully reproduce is important for both initial establishment into new areas and continued persistence of recently reduced small, isolated patches of plants. Ongoing habitat fragmentation makes understanding the complexity of these interactions critical for many plant species perseverance in nature. Pollinating seed predators are capable of both positive and negative effects on host plant reproduction and we have studied this interaction between two native North American species: *Silene stellata*, a herbaceous perennial, and *Hadene ectypa*, its obligate pollinating seed predator. However, *S. stellata* is only facultatitively dependent upon *H. ectypa* for pollination because other noctural moth copollinators are equally effective at pollen transfer. Because *H. ectypa* is a specialist whose young are dependent on *S. stellata* as a host plant, we hypothesize that adult *H. ectypa* will confer similar pollination service and subsequent initial reproductive success on both isolated and non-isolated plants, but isolated plants will experience greater herbivory because of their physical isolation.

Hadena ectypa was consistently a more important pollinator than other nocturnal moth copollinators for both isolated and non-isolated plants. However, *H. ectypa* pollinator importance decreased for isolated plants due to lower pollen deposition in isolation compared to non-isolated plants. Oviposition was similar between the areas, but isolated plants experienced higher predation than non-isolated plants. Thus seed set of isolated plants was significantly lower than for non-isolated plants. Component Allee effects caused by lower pollination levels and higher predation levels may limit plant population expansion or persistence in isolation, thererby demonstrating the importance of species interactions in conservation of biodiversity, especially in areas with increased habitat fragmentation.

O3 – How does resource diversity in different landscapes affect stingless bee colonies?

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Recent declines in wild and managed bees have raised global concerns about loss of pollination services. There is much evidence that diverse landscapes support a greater diversity of different pollinators than low diversity landscapes, but they also provide single species with a higher diversity of resources to exploit. However, little is known about how resource availability and diversity affect the ecology of pollinators.

We compared foraging behavior and colony development of managed hives of the Australian stingless bee *Tetragonula carbonaria* (Apidae: Meliponini) in different landscapes (macadamia plantations, natural forests and suburban gardens), representing different levels of resource diversity. Pollen, nectar and resin intake were observed to unravel influences of landscape, season and resource quality on colony foraging behavior and fitness. Foraging patterns and colony weight gain were monitored across the season, to determine effects of differences in seasonal resource availability.

We found that the diversity of resources collected was reduced in plantations, and that seasonal shortages in food availability strongly affected colony weight, although foraging patterns were largely similar across different landscapes. Moreover, pollen and sugar intake were smaller in plantations than in gardens and forests, whereas resin intake was similar across landscapes. Colonies in plantations additionally faced a higher pest and predation pressure. In contrast, hives in suburban gardens exhibited the strongest colony growth, demonstrating that food resource availability and diversity is one of the key factors in regulating colony growth and hence populations of social bees.

O4 – Mass-flowering crops and pollinators: Winners, losers, and a general pattern

Frank Jauker[1], Volkmar Wolters[1]

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By providing ample of nectar and pollen, mass-flowering crops have been suggested to counteract ongoing pollinator declines in modern agro-ecosystems. Lately, however, these positive effects were shown to be transient and highly trait-specific. Two factors most likely explain the unanticipated negative responses of pollinators: i) due to the pulsed provision of resources from mass-flowering crops (i.e. high in magnitude but short in time) synchronization with the pollinator's life cycle becomes a critical factor; ii) pollinator species that are not able to utilize specific mass-flowering crops can be adversely affected by disproportionate benefits to competing species.
Those two factors can explain confounding responses reported in the literature, e.g. increased early colony growth of short-tongued bumblebees mediated by oilseed rape accompanied by decreasing densities of long-tongued bumblebees. Recent results gained by a study using trap-nests in 12 German agricultural sites differing in the amount of oilseed rape within the surrounding landscape suggest that population dynamics of a short-tongued solitary bee are strongly linked to the phenology of this species with respect to mass-flowering crops. Additional data on community dynamics at the same sites will be presented.
We attempt to generalize responses of pollinators to mass-flowering crops by evaluating the availability of the resource and the timing of mass-flowering in relation to the life cycle of pollinator species. Preliminary results suggest that species not directly linked to mass-flowering crops might experience negative effects due to increased competition with subsidized species and increased pressure by antagonists benefitting from mass-flowering crops. Consequently, the benefits of winners are at the expense of the losers and conservation measures at the landscape scale need to counteract pollinator losses within this group by specifically considering their needs.

O5 – Pollination of *Camelina sativa* and *Thlaspi arvense*: Two new potential oil crop species in Germany

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Ever increasing worldwide energy consumption has lead to a steep rise of biofuel feedstock production in agriculture. However, its ecological sustainability is questioned.
Evaluating biodiversity and ecosystem services of biofuel feedstock production is essential for the assessment of ecological sustainability. A full understanding of the breeding and pollination system of plant species considered for feedstock is crucial to evaluate the importance of pollination services for biofuel agroecosystems and thus their sustainability.
False flax, *Camelina sativa* and pennycress, *Thlaspi arvense* are potential crop species considered for biofuel production in temperate areas such as Germany. Little is known about their pollination mechanisms. Thus, the objective of this study was to assess the pollination and breeding system of both species.
We conducted pollination experiments and observed flower-visiting insects on experimental plots in Dundenheim, Baden-Württemberg, Germany. *Camelina sativa* and *Thlaspi arvense* were grown from

June until September. Pollination treatments included self pollination, wind pollination, hand cross pollination and open pollination. Treatments were conducted on a whole-plant scale using ten plant individuals each. After harvest we counted the seeds and calculated fruit set, number of seeds per open flower and seed weight per open flower as measures for pollination success. Flower visitors were surveyed by half-hour transect walks.
Preliminary results point to a breeding system based on self pollination for *C. sativa* and wind pollination for *T. arvense*. *C. sativa* showed higher overall visitation rates compared to *T. arvense*. Also, honeybees were abundant in *C. sativa*, but were not found at all on *T. arvense*.
Our results indicate that both potential biofuel crop species produce without pollinators, but attract different pollinator functional groups by providing flower resources at times of the year when no or few other crop fields are in bloom.

O6 – Organic farming favours insect-pollinated over non-insect pollinated forbs in meadows and wheat fields

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The aim of this study was to determine the relative effects of landscape scale management intensity, local management intensity and edges on diversity patterns of insect-pollinated vs. non-insect pollinated forbs in meadows and in wheat fields. Nine landscapes were selected differing in percent intensively used agricultural area (IAA), each with a pair of organic and conventional winter wheat fields and a pair of organic and conventional meadows. Within fields, forbs were surveyed in the edge and in the interior. Both diversity and cover of forbs were positively affected by organic management in meadows and wheat fields. This effect, however, differed significantly between pollination types for species richness in both agroecosystems and for cover in meadows. Hence for the first time, we showed that pollinator-dependent plants benefit more from organic management than non-insect pollinated plants regardless of agroecosystem type and landscape. These benefits were generally more pronounced in meadows than in wheat fields. Finally, the community composition of insect-pollinated and non-insect-pollinated forb communities greatly differed based on the management type. In summary, our findings in both agroecosystem types indicate that organic management generally supports high species richness and cover of insect-pollinated plants disproportionally, which is likely to be favourable for the density and diversity of bees and other pollinators.

O7 – Diversity and pollination in California almond

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California almond is a crop whose production is highly dependent on insect pollination. We investigated how pollen and pollinator diversity can affect almond pollination in northern California. We examined the impact of cross *versus* self pollination on the nutritional content of almond. Whole almond trees were exposed to different pollination treatments. One set of trees were caged to only allow self pollination and another set were hand pollinated with compatible cross pollen. Nutritional analysis of the almonds produced by these trees showed significant differences in the nutritional composition of the almonds. Differences in pollen delivery can have a knock on effect on the crop's nutritional value. In addition, we explored how pollinator diversity contributes to pollination service through spatial complementarity within the trees and response to high wind speeds. Honey bees and wild pollinators showed spatial complementarity within the almond trees. Under high winds, visitation by honey bees dropped dramatically. In orchard with wild bees, visitation levels were buffered as wild bee visitation did not decline as markedly under high winds. Insect diversity can improve the level of pollination service through spatial complementarity and help buffer pollination service to environmental change.

O8 – Bee pollination improves the commercial value and quality of strawberry fruits

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Bee pollination can be of high economic value by improving quantity and quality of crops. This topic has become of increasing interest, but is still insufficiently explored. Yield of seventy percent of the major agricultural crops benefits from pollination as an ecosystem service, including strawberries. However, the economic value of strawberry pollination and its influence on fruit quality are still unknown.
To fill these gaps of knowledge, we set up a field experiment with nine commercially important strawberry varieties randomly planted in 12 plots. The influence of bee-, wind- and self-pollination on the commercial value and several quality parameters of strawberry fruits was analyzed on two plants per variety and plot using exclusion treatments.
Bee pollination led to strawberry fruits with the highest commercial value across all varieties: bee-pollinated fruits were heavier and were assigned to higher trade-classes due to fewer malformations. Hence, bee pollination rendered fruits that were marketable with higher prices than wind- and self-pollinated fruits. We also showed that the firmness of strawberry fruits depended on bee pollination. Most varieties produced fruits with brighter red color and a more balanced sugar-acid-ratio under bee pollination.
Our results show that bee pollination plays a key role for the development of marketable strawberry fruits. For the first time, we show the importance of bee pollination for farmers, traders and consumers of strawberry fruits. Hence, the role of crop pollination as an important and free ecosystem service may

be even more significant than recognized until now, and should be applied more systematically in agricultural management and policy.

O9 – Ecological enhancement of agricultural land in the Upper Rhine Plain

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In the project "Ecological enhancement of agricultural land in the Upper Rhine Plain" ecological enhancement measures were implemented in two locations with very intensive field management and clearing of the agricultural landscape. Two test plots of 50 ha in size were selected at each of the two locations, one for implementation of the enhancement measures and the other as a control plot. On 10 % of the former area (some 5 ha), measures in the form of flowering patches or strips, bee banks and nesting aids for wild insects were implemented since 2011. In the second, the control area, no enhancement measures were carried out. In the first year (2010) of the project the actual natural state of all test plots was recorded, in 2011 and 2012 the changes of the wild bees and butterflies are studied on both the enhancement and control plots.
A comparison of the total species numbers of wild bees on the flowering plots established that the latter are very well accepted by the wild bees. On both farms, numbers of the latter were markedly higher than the values recorded on the grass tracks in the initial year, 2010. In addition the number of recorded individuals was the multiple of that of the control plots.
Flowering plots can therefore already be identified as providing a meaningful contribution not only to the stabilisation and promotion of wild bee populations as pollinators of agricultural crops, but also for the diversity of wild bee biocoenosis. Further results will also be presented regarding species composition and comparisons between natural habitats.

P1 – Bee diversity and functional complementarity effects on pollination - an experimental test

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It is generally assumed that biodiversity is important for ecosystem functioning, a paradigm of increasing relevance in the face of global environmental change threatening biodiversity. However, studies about diversity effects in pollination, which is an important ecosystem process, are extremely scarce. We set up an experiment with 14 different flowering plant species in 56 flight cages of eight square meters inhabited by different combinations of one to five wild bee species (and controls). Thereby, we are able to test the biodiversity-functioning relationship for pollinator diversity for the first time in a realistic scenario, controlling for abundance and environmental effects. Our study showed a general trend for a positive effect of pollinator diversity on pollination success of a plant community representing a diverse array of plant families and flower types. Focusing on the underlying mechanisms revealed that functional complementarity with respect to weather conditions and flower preferences explains the pollination effect of bee communities much better than the number of species. Bees reduced interspecific niche overlap in the presence of other species, which further increased complementarity. We conclude that biodiversity-ecosystem functioning relationships are important in pollination systems, but knowledge on biological traits and mechanisms strongly improves the ability to predict the pollination value of different bee communities.

P2 – Effects of mass-flowering crops on pollinator communities in agricultural landscapes

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Pollinator communities are negatively affected by multiple environmental pressures, but combined effects of these pressures and consequences for pollination functions across Europe are not well understood. One important factor that influences pollinators is the current expansion of mass-flowering crops. Spill-over effects between these crops and semi-natural habitats can enhance pollinators. On the other hand wild plants may compete with mass-flowering crops for pollination services. To study these effects a network of 96 study sites was established in 6 countries in 2011 in the framework of the EU-project STEP (Status and Trends of European Pollinators). We focus on local, landscape and temporal scale effects of mass-flowering crops on pollinator visitation rates, abundances and diversity. Further on, we aim to investigate how land-use intensity and the amount of semi-natural habitats at the landscape scale can modulate these effects. In a common study design we survey pollinator communities in semi-natural habitats, different mass-flowering crops (e.g. oil-seed rape), and perennial field boundaries. Additionally, population dynamics and reproductive success of bee-populations are assessed with trap nests over two consecutive years. The overall aim is to perform a comprehensive and comparable study on a European scale.We will give an overview of our study design in the STEP project and present first results from the German study region.

P3 – Effects of species traits and spatial neighbourhood on *Protea*-pollinator interactions

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The dependence of plant fecundity on animal pollinators is likely to vary with species' traits and spatial context. To examine the importance of animal pollination for plant fecundity in different species and spatial neighbourhoods, we studied seven serotinous, bird-pollinated species of Sugarbushes (Fam.

Proteaceae, Genus *Protea*) and their key bird pollinators (the Cape Sugarbird *Promerops cafer*and 3 Sunbird species of the *Nectariniidae* family, in the South African fynbos, a worldwide biodiversity hotspot. We investigate (1) to what extent *Protea* species with contrasting floral traits depend on bird pollinators and (2) experimentally test the effects of self and outcross pollen on fecundity of the same *Protea* species We conducted pollination experiments in 2011 on more than 250 plant individuals growing in different spatial neighbourhoods, and collected over 800 *Protea* cones in the following year. These studies will provide insights into how strongly different *Protea* species depend on bird pollinators. Such a quantitative spatial understanding of *Protea*-bird interactions is necessary to assess whether a decrease of population size reduces *Protea* fecundity and thus may push *Protea* populations into an extinction vortex.

P4 – Interaction between plants, protective ants and pollinator thrips on the reproductive organs of myrmecophytic *Macaranga* (Euphorbiaceae)

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The genus *Macaranga* includes about 300 species mostly distributed in Southeast Asia. Among them, about 30 species are myrmecophytes, which are highly protected by symbiont ants *Crematogaster*. The myrmecophytic species of *Macaranga* offer the ants hollow stems as nest sites and food rewards such as extrafloral nectaries and food bodies. In turn, the ants exclude herbivores from host plants. On vegetative organs, plants receive only positive effects from ants. Meanwhile, on reproductive organs, plants may receive both positive and negative effects from ants because ants may exclude not only herbivores but also pollinators. We investigated how plants, ants and pollinators interact on the inflorescences of *Macaranga*.

The myrmecophytic *Macaranga* are specially pollinated by thrips of 1-2 mm in length belonging to *Dolichothrips* or unknown genus of Phlaeothripidae. The thrips breed on the inflorescences *Macaranga*. Many species attracted ants to inflorescences by food bodies and/or extrafloral nectaries. The ants may protect inflorescences from herbivores since ant-excluded inflorescences had more damage than controls. Meanwhile, the ants may not exclude pollinators since the number of thrips did not differ between ant-excluded and control inflorescences. This may be because protective bracteoles that limit ants but not thrips act as refugia for thrips. In addition, the pollinator thrips might secrete ant repellents from anus and avoid attacks from ants. Thrips often raised their abdomen when they encountered with ants, and then the ants often ran away from the thrips.

Thrips pollination in *Macaranga* may be suitable for myrmecophytes in that pollinator thrips are resistant to ants and bracteoles protect the pollinators from ants. In the genus *Macaranga*, thrips pollination is seen only in myrmecophytic species. Gain of thrips pollination might have allowed evolution of myrmecophytes.

P5 – Low pollination success in a small population of the Iberian pear *Pyrus bourgaeana*: Allee effect or endogamic depression?

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Frequently, in small populations a lower population size would reduce individual fitness and population growth (i.e., Allee Effect; AE). However, individuals in large populations can also experience reduced fitness if, for example, they show a strong relatedness that limits their survival or reproductive performance (i.e., endogamic depression). Weaimed to assess the relative importance of these two potentially conflicting processes in a small and low density population of the entomophilous self-incompatible Iberian pear *Pyrus bourgaeana* in southwester Spain. Because a fraction of adult trees are strongly aggregated in clusters of 8–10 individuals (within a radius of ~25 m) and since most pollinators move relatively short distances and thus are less likely to find, visit and spend time in isolated trees relative to those in large groups, we hypothesized that isolated individuals would experience higher pollen quantity and/or quality limitation as compared with aggregated individuals. Conversely, because our previous field and genetic data indicated that adult *P. bourgaeana* within a given group are often related, we also hypothesized that aggregated trees could experience higher pollen quality limitation as compared with isolated trees. To evaluate these possibilities, we carried out a series of hand-pollination experiments in eight tree groups using pollen from individuals within and outside of the groups. We found that early pollination success for the "outside-the-group pollen" treatment (51.9%±11.7) was 2.1 and 1.6 times higher than for "within-the-group pollen" (25.2%±9.2) and "natural pollination" (32.8±15.6) treatments. Furthermore, only 0.0 and 2.0±7.5 of the early-succeeded fruits from the "within-the-group pollen" and "natural pollination" treatments, respectively, completed the full development, as compared with the 17.9%±2.7 for the "outside-the-group pollen" treatment. These results suggest that in *P. bourgaeana* groups most of the pollen moved by pollinator come from close relatives, and thus individuals experience strong pollen quality limitation. Also, our target population is more likely to be experiencing endogamic depression than Allee effects.

Session 28 – Population ecology

Chairs: Heike Feldhaar, Markus Fischer

O1 – A demographic approach to study effects of climate change in desert plants

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Desert species respond strongly to infrequent, intense pulses of precipitation. Consequently, indigenous flora has developed a rich repertoire of life history strategies to deal with fluctuations in resource availability. Examinations of how future climate change will affect the biota often forecast negative impacts, but these -usually correlative- approaches overlook precipitation variation because they are based on averages. Here, we provide an overview of how variable precipitation affects perennial and annual desert plants, and then implement an innovative, mechanistic approach to examine the effects of precipitation on populations of two desert plant species. This approach couples robust climatic projections, including variable precipitation, with stochastic, stage-structured models constructed from long-term demographic datasets of the short-lived Cryptantha flava in the Colorado Plateau Desert (USA), and the annual Carrichtera annua in the Negev Desert (Israel). Our results highlight these populations' potential to buffer future stochastic precipitation. Population growth rates in both species increased under future conditions: wetter, longer growing seasons for Cryptantha and drier years for Carrichtera. We determined the importance of survival and size changes for Cryptantha and the role of seed bank for Carrichtera. Our work suggests that desert plants, and thus the resources they provide, might be more resilient to climate change than previously thought.

O2 – Modelling population dynamics of the spruce bark beetle Ips typographus under climate change

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The European spruce bark beetle *Ips typographus* (L.) is one of the most significant insect pests in European spruce forests. Its epidemic outbreaks are usually triggered by large-scale disturbances like winter storms or extensive droughts. Both demographic parameters of this beetle and resistance of its spruce host trees strongly depend on climatic parameters such as temperature and precipitation. Therefore, an increase in temperature and drought frequency due to climate change is likely to alter outbreak patterns.
We use dynamic simulation models to study the effect of climate change on phenology and population dynamics of this bark beetle in Switzerland. Particularly, we are interested how temperature increase affects the number of generations per year, swarming dates and, overwintering stages.

Using Bayesian model calibration, we parameterize the model for Switzerland based on intra-annual data of pheromone traps. This approach allows evaluating parameters like temperature thresholds for development and swarming. Based on the parameterization results we investigate the development under different climate scenarios.

We observe a shift in the number of generations of the spruce bark beetle with warmer temperatures. Especially, at lower altitudes (i.e. Swiss Central Plateau) three generations per year become more likely. Likewise, at higher altitudes where currently usually one generation can develop, a second generation might appear more often. Also, spring and summer swarming periods occur earlier in the year.

Our results clearly show the direct effect of climate change on the beetle's phenology. However, also indirect climate effects like extended and more frequent drought periods that lower the resistance of host trees might play an important role altering population and infestation dynamics, the risk of attack and the course of an outbreak. Therefore, we will discuss how to incorporate host tree disposition in the model and how model results can be transferred to forest practice.

O3 – Patterns of population dynamics of forest insects and the need for their explanation

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The professed aim to manage forest ecosystems in a sustainable and sound manner receives increased attention in the light of effects caused by changing climatic conditions. Important prerequisites and requirements in this context focus on a detailed understanding of processes and interactions in forest ecosystems.

However, to this date very little seems to be known about the truly complex response of insect populations in forests on climate change and rigorous weather events. After all the question remains on how those responses in our forests can be extrapolated and transformed into future scenarios, and what natural processes are involved to foster the stability and resilience of forest habitats.

Combining long-term observational studies with comparative forest and weather monitoring can yield a deeper understanding of the contribution of stand structure or diversity and microclimate to population and community dynamics. Long-time data of the pine looper moth, *Bupalus piniarius* (L.), are showing significant increases in pupal weight despite higher parasitation rates over the last three decades, while the pine beauty moth, *Panolis flammea* (Schiff.), has shifted regional distribution patterns.

We analysed quantitative monitoring data - namely male/female ratio, pupal weight, parasitation rate and vitality of male and female pupae - focussing on population traits in time and space during oscillation. Climate provides a general framework for changing population patterns but does not explain it all.

O4 – Implications from behavior, stress and habitat: Wildlife management in the Capercaillie (*Tetrao urogallus*)

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Capercaillie (*Tetrao urogallus*) occurrence is decreasing due to its dependence on large spatial forest areas that are diversely structured. In consequence, the species is heavily threatened with few remaining populations in Central Europe. One of the largest populations is located in the Bohemian Forest (National Parks "Bayerischer Wald" and Šumava and surrounding Landscape Protected Areas). To assess the status and threats of this population we gathered presence-absence data, abundance of birds, habitat quality and adrenocortical activity(corticosterone metabolites from droppings). Moreover, year-round human disturbance defined as intensity of recreation and forestry activity per grid cell of the study areas was assessed through expert-survey and was then tested as predictor for habitat use and stress load. Recreation and forestry intensity were not found to be significant factors determining presence-absence, meaning that birds used patches where humans were present. However, intensity of recreation significantly influenced frequency of Capercaillie presence in a given plot indicating that they prefer patches rating lower in human disturbance. Both recreation and forestry were determined to be influential factors in Capercaillie stress load (CM values), but were not exclusive in explaining the response variable. Further, habitat quality turned out to be an important factor influencing both,the behavioural and physiological parameters. It is therefore concluded that a relationship between human disturbances, habitat use and endocrine status does exist. Thus, our study underscores the importance of stress ecology research in the context of conservation and wildlife management. Based on the results, Capercaillie conservation and management plans should maintain to keep refuges of adequate size and of high habitat quality free from human disturbance, particularly during critical seasons such as winter, lekking and breeding time.

O5 – Enhanced Moran effect in autocorrelated environments

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Natural populations experience ongoing fluctuations of the environmental parameters that fundamentally influence their growth. Regional weather fluctuations are mostly correlated with each other by the supra-regionally acting climate. It has been shown that such correlated environmental stochasticity ("noise") may synchronize spatially disjunct populations in the absence of migration or indirect interspecific interactions like predation, for instance. Moreover, the degree of synchrony between populations, given by the correlation coefficient r_p, equals the correlation coefficient of the

environment r. This relationship is known as the Moran theorem ($r_p = r$), or more loosely Moran effect ($r_p \leq r$).
In nature, environmental stochasticity or "environmental noise" is generally characterized by some degree of autocorrelation ("noise color"). That is, present parameter values are related to past ones. So far, no studies addressed the Moran effect for populations living in differently autocorrelated environments. By the combined use of mathematical modeling and chemostat experiments, we investigated the Moran effect in three comprehensive scenarios. In the model as well as in the experiments, environmental stochasticity was imposed as fluctuations of the dilution rate. We show

1. that the Moran effect holds for populations experiencing Gaussian (white) noise in identical habitats (with respect to dilution rates and external nutrient supply concentrations), $r_p = r$,
2. that deviations occur when Gaussian noise affects populations in differing habitats, $r_p < r$, and
3. that when accounting for differences in noise color populations in identical habitats can be more synchronized than the environment, $r_p > r$.

Since environmental fluctuations are in this case the only force driving population dynamics, the last point is absolutely surprising. Intuitively, populations should not have larger correlation coefficients than the environment. However, this statistical phenomenon holds, no matter whether one uses Pearson's product-moment coefficient or rank correlation coefficients like Kendall's τ or Spearman's ρ to quantify synchrony. Our findings point out that errors might be made when correlating time series especially of field populations. Such errors could be avoided by including the differences in autoregressive processes into data analysis.

P1 – Current trends in forest development in the Kellerwald-Edersee National Park

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The Kellerwald-Edersee National Park was founded in January 2004 and is included on the UNESCO’s world heritage list for old beech forests since 2011. According to this status the area is mainly unmanaged since about two decades which provides the great opportunity to track potential changes in distribution patterns of tree species and forest composition caused by natural development. Consequently, we analyzed the relationship between the dominant tree species taking into account young and old life stages and major environmental drivers.
The data set based on the Permanent Inventory Sampling Procedure (PSI) of the Kellerwald-Edersee National Park administration and the forest site mapping of Hessen-Forst. Using the habitat modeling approach, the structuring tree species, especially beech, hornbeam, oak, spruce and larch with their different life stages were tested in relation to soil moisture, precipitation, altitude, exposition, inclination, northing and easting. In a further step, the habitat models will be spatially extrapolated using a GIS to quantify habitat availability of the different entities.
First results of this ongoing study show clear differences in distribution patterns for both, tree species along an altitudinal and precipitation gradient as well as life stages mainly along a soil moisture gradient suggesting initiating changes in forest composition and species distribution.

P2 – Sex determination of Capercaillie (*Tetrao urogallus*) droppings: direct measurements vs. genetic approach

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Sex of focal species is a fundamental ecological parameter that is often difficult to assess in the field. Especially when dealing with rare or endangered species, non-invasive methods are used to measure population ecological parameters. We used the highly endangered Western Capercaillie (*Tetrao urogallus*) that shows a pronounced sex dimorphism in body size to evaluate whether the sex can be determined using dropping size. During two consecutive winter seasons, we collected about 1,400 droppings in one of the largest relict populations in Central Europe, the Bohemian Forest. The study area comprises the National Parks Šumava (Czech Republic), National Park "Bayerischer Wald" (Germany) and forest areas in the surrounding landscape protected areas. During fieldwork we estimated sex (larger for males than females) for each dropping. Back in the laboratory, we measured the exact diameter of droppings and applied chromosome specific genetic methods to determine the sex. Our genetic data indeed revealed highly significant differences in diameters between the two sexes (mean diameter for females 8.72 mm [N=182]; for males 11.03 mm [N=279]). However, the overlap of diameter values was high. Comparing genetic data with field estimation showed an overall misestimation of 15.6%. Here, about 20% of female droppings were estimated to being of male origin, whereas misclassification of males being females was much lower (10.4%). Thus, only genetic sex determination provides 100% accurate data. Still, sex prediction using dropping diameters showed a surprisingly high accuracy and might serve as a low cost alternative for some ecological questions.

Session 29 – Remote sensing

Chairs: Hannes Feilhauer, Pedro J. Leitão

O1 – Vegetation classification in alpine habitats: a combination of field surveys and satellite images interpretation

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The alpine area has a wide range of vegetation distribution. This habitat is composed of a mosaic of different and sometimes species-rich vegetation types, such as alpine meadows, dwarf shrubs, scree- and pioneer vegetation, crevice vegetation, etc. The flora of these sensitive habitats is endangered, due to changing farming practices and climate change. Despite of numerous efforts, until now, it has not been possible to interpret satisfactorily the variety of vegetation types of the Alpine region based on satellite images. Therefore, mapping of vegetation types based on satellite images has not been possible. The aim of this study, which is a part of the project "Habit Change" (INTERREG IV B Central Europe Programme), is to combine the dynamics of vegetation development (phytomass, PAI over the course of one year) with multiple satellite images over the growing season (June - October 2012) and thereby to achieve a better classification and spatial identification of the variety of vegetation types. Data were collected through basic field surveys in the Nature Park Rieserferner Ahrn. Therefore five representative transects (altitude: from 1576m to 2603m), which differ in geology, exposition, elevation, slope, farming systems, were selected. Along these transects, 129 vegetation assessments according to the method of Braun-Blanquet (1946) were made and 29 different vegetation types have been characterized. From June to October 2011, in four different time steps, 520 vegetation samples (characterized by vegetation types) with a bounding box of 30cm x 30cm were taken. Furthermore in the same period - from June to October 2011 - geostatistical analysis of vegetation- and phytomassdistribution along these transects (altitude) (variation of: minimum biomass: $27g*m^{-2}$, maximum biomass: $2350g*m^{-2}$) and PAI measurements were made. Using these results, it will be possible to detect plant communities in alpine terrain on satellite images. Furthermore researcher will be able to classify vegetation and interpret their future evolution.

O2 – Relating Canopy Reflectance to Vegetation Composition of Mountainous Grasslands in the Greater Caucasus

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Mountainous grasslands in the Greater Caucasus cover vast areas from the montane to alpine zones. Species richness is remarkably high and the coarse spatial pattern of the distribution of grassland communities is fairly well known due to extensive research conducted by Georgian botanists over the past decades. However, the underlying main environmental drivers of grassland composition - topography, soil conditions and land use intensity (freerange grazing vs. mowing) - change gradually. The resulting moderate compositional shifts pose a challenge for vegetation mapping by means of remote sensing. Classification-based approaches fail due to the lack of discrete grassland patches with distinct spectral responses.

Hyperspectral mapping of vegetation composition has however proven to be a successful solution for high resolution vegetation mapping in 'gradient landscapes'. Since there are no hyperspectral images yet available for the study region, we used field spectrometric data to test this approach in the Kazbegi region, Georgia.

To assess grassland compositional dissimilarities, the vegetation data of 60 subalpine grassland plots were reduced to two metric variables by NMDS ordination (based on Bray – Curtis dissimilarities). An underlying cluster analysis revealed groups of similar plots, which were in accordance with the most dominant grassland types of the region. Vegetation structure and environmental gradients were related to the ordination.

Reflectance (325 - 1075 nm) was measured with a field spectrometer twice on two dates and was related to species composition (NMDS axes) by PLS-Regression. Reduced spectral datasets of the best models were subjected to PCA ordination to arrange plots by spectral similarity. Similarity between vegetation composition and spectral response was assessed by Procrustes rotation.

O3 – Choosing remote sensing data products for use in species distribution models

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The improved knowledge on species distribution patterns is widely accepted as of foremost importance in the fields of climate change science and conservation biology. Indeed, research on species distribution modelling has boomed in the last 10 years, with the development of complex algorithms capable of dealing with typically biased or incomplete ecological data. Remote sensing data products provide unique opportunities for use in species distribution models, particularly by enabling the detailed prediction of species occurrence maps over wide areas, at various scales. The panoply of processing methods and of existing remote sensing data products however, can make the choice of the best suitable method or product particularly difficult. In this paper, we compare the use of different data products in a species distribution modelling case study, using Boosted Regression Trees. For this purpose, both model predictive performances and prediction maps are compared. While no significant differences were found in model performances across products, the predicted occurrence patterns sometimes differed considerably. These results raise concern in the choice information-extraction method for use in such studies. We further discuss this issue with respect to ecological niche theory and pragmatic considerations on model and data properties, in the search for best practises. Finally, we provide a set of general guidelines for choosing fit-to-purpose remote sensing products for distribution modelling studies.

O4 – Detection of land-cover change by invasive woody species spread at the Río Negro, Patagonia

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The riparian ecosystem of the upper Río Negro in northern Patagonia, Argentina, is an invaluable biodiversity resource and provides important ecosystem services.
In the last few decades, however, the establishment of non-native woody plant species, particularly taxa from the Salicaceae family,*Elaeagnus angustifolia*, and *Tamarix* spp. have probably led to major land-cover transformations that will affect ecosystem traits and native species. Even so, no comprehensive investigation of land-cover and land-cover changes has been attempted so far.
Consequently, our study aimed at mapping land-cover and detecting land-cover changes in the region with special focus on the spread of invasive woody species in order to understand invasion dynamics and assist in assessing the impact on the riparian ecosystem and the native vegetation. Classification tree analysis, a supervised classification approach, was applied to Landsat images of the upper Río Negro valley from 1986, 1992, and 2003 in order to map land-cover. Changes were detected between subsequent years and over the complete investigation period via post classification comparison.
Change detection confirmed that severe land-cover transformations have taken place in the riparian ecosystem, including a vast increase of forests and woodlands dominated by invasive woody species. Thus, we could prove that there is a severe threat to the upper Río Negro riparian ecosystem by invasion of woody species, which will probably have significant consequences for native species and ecosystem traits.

O5 – Optimizing the spatial configuration of rapeseed fields with respect to natural pollination

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Given the extensive losses of honeybee populations during the last 20 years, the ecological and financial importance of natural pollination by insects to agricultural crops, improving their quality and quantity, has attracted more and more attention. However, the supply of this ecosystem service by wild pollinators largely depends on the availability and spatial distribution of both nesting habitats and natural foraging sites, e.g. grasslands and edge habitats. One of the most important crops dependent on pollination in the study area of this analysis, the surrounding of the city of Leipzig (Germany), is rapeseed. In this study, flowering rape fields as well as the major land cover types (forest, grassland, other agricultural areas, settlements, and water bodies) are identified based on Landsat 5-TM data acquired on 05/01/2011. The pollination service is estimated based on the distance between potential bee nesting habitats and rapeseed fields in the initial, real landscape. Further, an optimization model is implemented using a genetic algorithm approach which aims at maximizing yield for rapeseed through optimization of the provision of pollination. The optimization model aims to identify optimum spatial configurations of rape fields within the existing network of arable land. Within the optimization

approach, different scenarios (increase and decrease of cultivated areas with rapeseed of up to 30% in comparison to the reference area in the year 2011) are considered. In addition, the optimization results are compared with the initial landscape based on landscape metrics (e.g. homogeneity).

O6 – Mapping plant strategy types for spatial analyses

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In 1974, Phil Grime proposed the CSR-model to describe plant functional types as three major strategies. These strategies are competitive ability (C), resilience against stress (S), and ruderality (R). At the community level, the strategies reflect the productivity of a stand and disturbance at the site. Monitoring their spatial distribution may provide insights into vital ecosystem processes and functions. We tested the potential of imaging spectroscopy to map the spatial distribution of these strategies. Derivatives such as evenness and spatial change rates may further enable conclusions towards functional diversity.
Our test was implemented in the Wahner Heide area near Cologne, Germany. This area is a semi-natural heathland (~30 km²) that has been influenced by long-term civil and military use. Due to this history, it features a large variety of intertwined vegetation types that cover a broad spectrum of strategies. During a field campaign in August 2009, we sampled 195 vegetation plots on the basis of a random design. Simultaneously, imaging-spectroscopy data were acquired with the airborne sensor HyMap. We regressed community-related strategy scores against the corresponding canopy reflectance. The regression models (R^2 in validation of 0.63 for C, 0.63 for S, and 0.69 for R) were subsequently applied onto the image for pixel-based predictions of strategy distributions. The three resulting strategy maps were interpreted with respect to floristic composition, environmental conditions, and land use. Shannon's entropy was calculated per pixel from the strategy maps to assess the diversity and evenness of strategies. Finally, the spatial change of strategies was quantified. The maximum change rate per pixel was taken as functional expression of Whittaker's beta-diversity. This measure was used to identify areas where the prevailing strategy changes. The maps illustrate the functional response of vegetation to environmental conditions and disturbance.

P1 – High spatial resolution satellite data for monitoring fine-scale plant species spatial turnover in semi-natural grasslands

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Traditionally managed grasslands, such as pastures and hay meadows, support a high species diversity and are among the most species-rich habitats in northern and central Europe. Semi-natural grasslands have become one of the most threatened habitats and the number of semi-natural grassland species becoming extinct or red-listed, is steadily rising. The monitoring and management of grasslands has a high priority for conservation biology/ecology in Europe as in other parts of the world. The turnover of species is a central feature of spatial patterns in biodiversity and may provide important information within conservation management. The traditional methodologies for mapping of vegetation at detailed scales consist primarily of field surveying, which may be time consuming and expensive. There is currently a strong interest in developing alternative or complementary approaches. The recent launch of high spatial resolution satellites (e.g. Ikonos, Quikbird, Geoeye, Worldview) provides new possibilities for the use of satellite data in detailed mapping of vegetation. The present study focuses on the potential of high spatial satellite data for monitoring fine-scale plant species spatial turnover in semi-natural grasslands. Field work, including the on-site description of 105 pairs of semi-natural grassland plots (4 × 4 m), was performed to record response variables (Jaccard's and Bray-Curtis indices). High spatial resolution satellite data were extracted from each plot and explanatory variables (the spectral distances between plots) were generated from Worldview satellite data. Univariate and partial least square regressions showed significant associations between response and explanatory variables. Results from the study provide a base from which new approaches for ecological management of semi-natural grasslands may be developed.

P2 – Can hyperspectral remote sensing data be related to fine-scale plant trait diversity in grasslands?

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Ecologists are interested in linking biotic and abiotic factors to functional diversity to reveal patterns in community trait assemblages and ecosystem functioning. The traditional methodologies for mapping of vegetation at detailed scales consist primarily of field surveying, which may be time consuming and expensive. Additionally, the gathering of spatially continuous information on trait composition over extensive areas may be difficult. Previous studies have shown that canopy reflectance is related to several morphological traits. Remote sensing data may therefore potentially be used for the detection of plant trait diversity over wide areas. Semi-natural grasslands belong to one of the most species rich communities in northern and central Europe. There has been a massive loss of grassland area within the modern agricultural landscape and the number of semi-natural grassland species becoming extinct or red-listed, is steadily rising. The monitoring of grasslands has a high priority for conservation biology/ecology in Europe as in other parts of the world. The aim of this study is to examine the relation between hyperspectral data and fine-scale plant trait diversity. Data on the frequency of vascular plant species were recorded together with data on environmental properties (e.g. per cent bare soil, vegetation height) within 117 grassland plots (1 × 1m) (during summer 2011). Trait information was compiled from the LEDA trait data base. The location of the plots was determined with a high accuracy differential GPS (~cm). Hyperspectral (160 bands) airborne data was acquired over the area during summer 2011 with a HYSPEX sensor (0.5 m spatial resolution). Field plots were localized with very high accuracy in the spectral image. To our knowledge, this is the first study that uses spectral and species diversity data collected at the same spatial scale for examining the relation between the variables. Because of the high spectral resolution of the remote sensing data, we could detect differences between spectral signatures of plant communities which allowed us to discriminate communities, which are not distinguishable with multispectral sensor systems.

P3 – The potential of different satellite sensors for an assessment of habitat conditions

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For conservation management, vegetation mapping on a regular basis is an inevitable but time-consuming task. Management decisions are often based on an assessment of the actual habitat conditions (e.g., regarding the presence of degradation indicators or invasive species within habitats).
The question whether remote sensing can facilitate this task is frequently raised. Earlier remote-sensing studies focusing on mere habitat patterns provide many examples of success but also failure. The need for more detailed information on habitat conditions further increases the challenge for remote-sensing based vegetation mapping. Especially data of high spectral (i.e., hyperspectral) resolution are expected to make the success of remote-sensing techniques more reliable. The acquisition of such data is however costly and restricted to rather small geographical areas. Satellite sensors with moderate (i.e., multispectral) spectral resolution exist where these disadvantages do not apply. The potential of such sensors for an assessment of detailed floristic variation has not been systematically compared to date. We therefore tested the potential of ten sensors to map floristic gradients as extracted by ordination analysis using monotemporal and multiseasonal data sets. The respective simulated radiances were used to model floristic gradients within three types of spontaneous vegetation typical for Central Europe (a nutrient-poor grassland, a wet heath, and a floodplain meadow). Comparison of the model fits illustrated the variable potential of the sensors for an estimation of habitat conditions. The results showed that in particular sensors covering a large spectral range (e.g., from 400 to 2500 nm) are promising. Sensor data limited to the visible and very near infrared region (400 to 1000 nm) featured a weaker performance.

Session 30 – Soil ecology

Chairs: Liliane Ruess, Nico Eisenhauer, Judy Simon, Francis Q. Brearley, Anne le Mellec

O1 – Emerging ecosystems belowground

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The human-induced spread of species into new regions, rapid anthropogenic changes in climate and land use as well as new types of species (e.g. crops, ornamental plants) and biotopes (e.g. urban environments) lead to new species combinations which co-exist under new environmental conditions. In contrast to natural ecosystems, such so-called “emerging ecosystems” are not the result of a co-evolutionary history within communities, possibly resulting in a decoupling of common species interactions and therefore changed functioning of ecosystems. Several talks in this session will demonstrate that interactions involving soil biota are not only importantly shaped by new species but also by changing abiotic conditions and changes in native plant biodiversity. Thus, the dynamics in interaction webs belowground will be importantly affected by the interplay of a changed community structure and changed environmental conditions in future ecosystems.
The functioning of terrestrial ecosystems is largely dependent on processes belowground and any changes in soil functions may therefore have also feedback effects on global change phenomena. In recent years, a high number of studies demonstrated that the aboveground and belowground compartments of ecosystems show strong functional links. Manipulative experiments on global change effects, however, often focus on aboveground changes whilst many aspects of soil ecology are still underinvestigated. Especially, there is a lack of studies which consider the simultaneous action of multiple global change drivers (e.g. climate change and invasions). Furthermore, ecosystems under global change are often seen as unplanned experiments which provide new insights into ecosystem functioning and development. Since soil ecology has to deal with extremely complex systems on the one hand but often still lacks conceptual links to general ecological theory on the other, the research on global change effects on belowground systems provide an excellent opportunity to place soil ecological research into the framework of general ecological concepts.

O2 – A novel ^{14}C approach to follow fate of carbon in food webs at boreal organic peat soils

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Soils are the largest reservoir of organic carbon (C) in terrestrial ecosystems. The soil fauna and microbial biomass play an important role for C turnover. Separating variable C sources from soil and plants is challenging, but essential for a better understanding of food web structures and a better prediction of changes in communities responding to climate and land-use change. Relatively little data are available for the C-rich peat soils dominating in the northern latitudes which store a great amount (about 30%) of the global soil.

We introduce here a novel approach to follow the fate of old, native vs. young plant-derived C in a highly organic soil. Our innovation is to use plant cultivations on peat soil where the upper peat layers have been removed (cut-away peatland). There, the plants have a modern ^{14}C signature and the left-over peat is old (about 7500 years), being thus naturally depleted in ^{14}C. This large difference in age offers an ideal and unique possibility for separating C sources for the soil fauna and the CO_2 released from decomposition.

We showed from a perennial bioenergy crop (reed canary grass) cultivation and a young birch pine forest growing on cut-away peatlands in Finland that the isotope partitioning approach allows for quantification of native soil organic matter vs. recent plant derived carbon sources in microbial biomass, soil fauna, dissolved organic carbon and leaching waters. Most parts of the food web rely on recent plant material, only Lumbricidae earthworms and some predators from adjacent uncultivated soils (peat harvesting areas) incorporated relevant parts of their carbon from the native soil organic matter ranging from 24 % up to 40 %. Dating of CO_2 derived from soil respiration over two growing seasons showed that old peat decomposition contributed on a similar relative proportion to total soil respiration (30% of old carbon vs. 70% of recent plant material on average). The total amount of peat carbon losses from the cultivated, nutrient-poor site ranged from 392 to 549 g CO_2 m^{-2} $season^{-1}$.

The approach is reliable for source partitioning with isotopes and offers a new possibility to follow the fate of old, native soil organic matter in highly organic soils and understanding C pools and fluxes in the soil-plant-water-atmosphere system and the driving role of soil biota.

O3 – Fine-root litter dynamics: storage and turnover mechanisms of root derived organic matter in soils

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Fine root turnover contributes significantly to biogeochemical cycling in terrestrial ecosystems. Land use and management may affect root litter decomposition through changes in plant species composition and diversity, effects on the decomposer community and differences in nutrient availability. We established a large scale root litter decomposition study in three German regions using a standardized litterbag method for forest and grassland sites under different management, soil types and manipulations of the decomposer communities. In one setup of the experiment we used standardized root litter for forest and grassland sites at all 300 plots, and in a second setup root litter collected on-site was used. In total 5112 litterbags were buried at 10 to 40 cm soil depth. The main aims of these experiments are to analyze the links between root litter quality and decomposition rates and how these are affected by biotic and abiotic site conditions and soil depth. Quantifying the amount of carbon plants allocate to fine roots and their below-ground residence time is also necessary for the prediction of how ecosystems will respond to environmental change. Therefore we are also interested in measuring the radiocarbon (^{14}C) content of fine roots in order to estimate their mean residence time in different land uses. The decomposition of fine roots is expected to be faster initially for material collected on-site, to differ between land use types, management classes and climatic conditions,and to be influenced by abiotic/biotic soil properties and soil depth. We present the setup of the experiments and results of the first semester collection of litterbags in spring 2012 and of the radiocarbon analysis.

O4 – 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_2concentrations 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

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O5 – How do drying and rewetting stresses affect microbial processes in tropical forest soils?

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The response of soil microbial communities to drying and rewetting stresses was studied in three independent mesocosm experiments. The first experiment examined the effects of repeated drying/rewetting cycles, the second experiment examined the responses of soils from altered land-use to drying/rewetting, and the third experiment examined the interactions between the number of drying/rewetting cycles and soil depth. I found that land-use change and soil depth had strong effects on microbial processes and their interaction with drying/rewetting effects on microbial processes was important. In contrast, repeated drying/rewetting did not always have large effects on microbial processes but this was likely to interact with soil storage conditions. Different microbial processes show differing responses to the experimental treatments and thus examination of a range of responses will provide complimentary data.

O6 – Soil nematode and collembolan communities in mofette fields (natural carbon dioxide springs)

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Mofette fields, i.e. geogenic, cold CO_2-exhaling gas vents occurring naturally in regions of tectonic or volcanic disturbances, give an excellent opportunity to investigate long-term responses of the soil biota to increased CO_2 concentrations. Around the degassing vents, the upper centimeters of mofette soils present a small-scale mosaic of highly divergent CO_2 and O_2 concentrations: From normal soil atmosphere (ca. 0.1% CO_2) to elevated CO_2 concentrations predicted from climate change scenarios to highly altered atmospheres of up to 100% CO_2. Additionally there are fluctuations on time scale making life in mofette fields unpredictable. Still, an adapted vegetation of mofettotolerant and mofettophilous plant species often occurs in mofette fields. The present field study focuses on collembolans as representatives of the air-filled fraction of the pore system, and on nematodes as inhabitants of soil water films. We hypothesized that air and aquatic soil fauna will be affected differently by CO_2 elevation, O_2 deficiency, and soil acidity, and will accordingly have different strategies to cope with or avoid the extremes.
Canonical correspondence analyses revealed strong correlations between soil nematode and collembolan communities and environmental measures, above all CO_2, soil pH, organic matter, and plant composition. An increase of CO_2 concentrations was followed by a steady decline in collembolan and nematode species numbers, but below an ultimate limit had no significant effect on overall collembolan or nematode densities. Collembolans built populations at up to 19% CO_2, where some mofettophilous species had their highest densities and frequencies, but other more general species also occured (66%). Nematodes, on the other hand, grew individual-rich populations at up to 62% CO_2 but above 20% CO_2 nematode communities consisted almost entirely (97%) of 3 mofettophilous species. Possible consequences of this species reduction on ecosystem processes are discussed.

O7 – Linking aboveground and belowground: how foliar herbivory affects soil microarthropod communities

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Research focusing on terrestrial ecosystem functions recognizes to an increasing degree the need for studies with a combined aboveground-belowground approach. A process prone to strongly affect above-belowground feedbacks is the consumption of plant material by herbivores as it significantly alters the quantity and quality of resources entering the decomposer subsystem in the soil. We present current research from Sweden that investigated belowground consequences of aboveground foliar herbivory by larger mammals in Scandinavian boreal forest ecosystems. It examined how simulated different levels of moose densities altered microarthropod (collembolans, oribatid mites) abundance and community structure. The study made use of a long-term experiment in northern eastern Sweden where the effect of different intensities of moose browsing on a range of above-ground plant parameters along a forest productivity gradient had been investigated over a period of 10 years. It will be discussed how differences in abundance and species number of the soil fauna are related to the herbivory impact on plants (changes in amount and quality of litter, changes in root structure) and to differences in plant community composition along the productivity gradient. Differences in microarthropod communities regarding the occurrence of individual species or taxa and their relative abundance will be interpreted in relation to quantitative or qualitative differences in food resources (e.g. root biomass and fungal community composition) between sites. The general usefulness of collembolans and oribatid mites as indicator organisms for assessing belowground effects of aboveground herbivory is highlighted. However, treatment effects were not apparent at taxonomic levels higher than family level indicating the importance for high resolution assessments of animal communities.

O8 – Causes and consequences of nonnative earthworm disturbance severity in North American forests

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Nonnative plant and insect pests have long been recognized as important agents of global change. Although less visible, soil dwelling fauna and in particular nonnative earthworms are also becoming widely acknowledged as influential ecosystem engineers. In north temperate and boreal forests of North America, nonnative earthworms are associated with a large number of impacts that lead to significant changes in ecosystem processes and plant community composition. Although the likely pathways of introduction are well documented, site level factors that promote invasion and resulting disturbance severity are less well understood. To assess this issue, we sampled earthworm invasion severity and local environmental factors at 125 forest sites across a three state region. We utilized structural equation modeling (SEM) to quantify the relationships among abiotic and biotic factors associated with earthworm invasion severity.
Evidence of earthworm presence and disturbance was found at 93% of our sites and high to very high severity disturbance in 49% of forest stands. The SEM fit the data well (χ^2_7 = 2.07, p=0.96) and indicated multiple significant relationships. Soil pH and annual precipitation both had strong positive relationships with earthworm disturbance severity while overstory conifer basal area and summer temperature had negative relationships. Our analyses also found connections between earthworm disturbance, graminoid cover, and level of browse damage on maple (*Acer* spp.) saplings. Earthworm disturbance had a significant positive effect on graminoid cover which in turn had a significant positive effect on browse damage. These results indicate that widespread nonnative earthworm disturbance is likely altering dynamics in North American forests through direct and indirect impacts on multiple trophic levels.

O9 – On the complexity of plant-soil feedbacks under climate change

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To understand how climate change may affect above- and belowground ecosystem components, we investigated plant community and soil ecosystem responses to single and combined effects of elevated [CO_2], warming, and water availability. The experiment consisted of constructed old-field plant communities in open-top chambers, located in East-Tennessee. 1) Plant species differed in their responses to the climate change factors, altering community composition. Plant responses could have resulted from changes in physiology or from altered competitive interactions; however, changes in soil properties could also have contributed. 2) As indicators for soil ecosystem functioning, we measured activities of enzymes that take part in degrading a variety of compounds involved in C and nutrient cycling and we analysed nematode feeding group composition. We collected soil samples from under two dominant plant species, whose cover and biomass were significantly affected by the climate change treatments and thereby reflect the changes in plant community composition. Both for enzymes and for nematodes, we showed significant plant species ´treatment interactions, which indicate that direct effects of climate change on the soil system can depend on, or be overruled by, changes in the plant community. 3) After the experiment was shut-down, we collected soils from the chambers and tested plant growth responses under*common* conditions. To separate between abiotic and biotic effects, we grew plants on living and sterilized soils. Biomass production was generally higher on soils from the dry treatments than on soils from the wet treatments. Effects were stronger in living soils than in sterilized soils, suggesting that the observed effects primarily should be contributed to differences in the biotic soil component. These results indicate that climate change effects on soil properties influence plant performance, and hence, should contribute to net climate change effects on plant communities.

O10 – The bright side of soil life: positive soil feedback effects on plants

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Plants must cope with a large number of antagonists including competitors, herbivores, parasites and pathogens. Plants have evolved the ability to interact with soil organisms and select specific soil communities of microbes and animals. Those soil organisms, in turn, have distinct impacts on the performance of plants, a mechanism coined soil feedback effects. Although chiefly investigated in the context of pathogen accumulation and resulting plant community dynamics, many soil feedback effects are positive, and plants actively select for beneficial facilitators that improve plant growth and health. Despite common belief, such positive soil feedback effects are able to maintain plant diversity and thereby the functioning of plant communities. In this review we will present representative positive soil feedbacks involving diverse belowground organisms including microbes, arthropods and earthworms. We will then discuss some relevant mechanisms underlying such feedback effects, and show the ecological consequences of positive feedback effects on plant productivity and diversity.

O11 – How grassland plant species drive the abundance and activity of plant beneficial bacteria

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Some soil bacteria show antifungal activity and are able to protect plants against pathogens. In order to foster bacteria-mediated plant protection, factors affecting the dynamics of these bacteria need to be understood. Plants act as drivers of root associated bacterial communities and our recent results showed that increasing plant diversity enhances the abundance of plant pathogen antagonistic pseudomonads. Additionally, their abundance was negatively influenced by legumes and positively by grasses. However, the effect of plant diversity and identity on antagonistic bacterial activity is still unknown. We investigated the density and expression of antifungal genes (coding for 2,4-DAPG, pyrrolnitrin and hydrogen cyanide) by using established GFP reporter fusions of the model biocontrol strain *Pseudomonas fluorescens* CHA0 colonizing the roots of plants grown alone or in mixed cultures. Plant identity was the main factor affecting bacterial abundance and gene activity. In addition, interspecific interactions in three species combinations increased bacterial abundance and activity. Bacterial abundance and activity was the highest in presence of grasses, whereas legumes in general negatively affected their abundance. In particular, the grass species *Lolium perenne* supported very dense bacterial populations with a high activity of all tested antifungal genes. The results underline the importance of biodiversity as well as the role of key species for ecosystem functioning. Plant polyculture i.e. the use of certain plant combinations may foster plant-protective bacterial communities and may help establishing environmentally friendly control of plant diseases.

O12 – Temporal and spatial stability of microbial functions are driven by plant diversity

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Recent studies found biodiversity to reduce the temporal and spatial variability of soil processes thereby stabilizing ecosystem functioning. These relationships call for a better understanding of the mechanisms responsible for increased stability in more diverse systems. Crucial functions of the soil system include decomposition and element cycling. One key group of organisms driving these ecosystem functions are soil microorganisms. We investigated spatial and temporal stability of soil microbial respiration and biomass along an experimental plant diversity gradient from one to 60 plant species with varying plant functional group composition in semi natural grassland (The Jena Experiment). We determined temporal variability as the coefficient of variation of annual measurements differentiating two phases of the experiment: after 1, 2 and 4 years (establishment phase) and after 5, 6 and 7 years (consolidation phase). Spatial variability was calculated as the coefficient of variation of five samples per plot eight years after establishment of the experiment. The effect of plant diversity on temporal stability of microbial functions varied significantly between phases: plant diversity destabilized microbial functions in the establishment phase, whereas it stabilized them in later years. By contrast, spatial stability of microbial functions was mainly driven by the presence of key plant functional groups: spatial stability was significantly reduced in the presence of tall herbs and legumes, whereas it was increased in the

presence of grasses. These opposing effects of different plant functional groups were due to differences in root biomass and distribution with grasses building a more homogeneously distributed root system and forbs building a more patchy distribution of roots. Our results show that the stability of soil microbial functions is significantly affected by the diversity and composition of the plant community. Plant diversity and the presence of key functional groups thus are essential to maintain the stability of crucial soil processes.

O13 – Density, diversity and species assemblage of mesostigmatid and oribatid mites in grassy arable fallows of different age

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Density, diversity and species assemblage of mesostigmatid (predatory) and oribatid mites were investigated in nine grassy arable fallows according to a factorial design with age (young: 2-3, middle-aged: 6-8, old: 12-15 years) and plant species (legume: *Medicago sativa*, herb: *Taraxacum officinale*, grass: *Bromus sterilis*) as fixed factors. Four plots were randomly chosen at each fallow in May 2008. At each plot plant roots and the adjacent soil of five plant individuals were sampled with steel cylinders for heat extraction of soil fauna and measurement of environmental parameters.
GLM analysis using SAS revealed a significant effect of plant species on predatory mites with higher mite density in *B. sterilis* than in *T. officinale* samples, and *M. sativa* samples being intermediate. This might be caused by the propagation of a bottom-up effect of the grass *B. sterilis* suggesting that resource quantity may be more important than resource quality. There was no age effect on predatory mite density. No effect of age or plant was shown for predatory mite diversity. In contrast, oribatid mites were not affected by plant species but showed a significant age effect on density and diversity. The density of oribatid mites was significantly higher in young than in old fallows, and middle-aged fallows being intermediate. Oribatid diversity and evenness were significantly lower in mid-aged fallows than in young and old ones.
A canonical analysis of principal coordinates (CAP) shows that predatory and oribatid species assemblages were different between age classes. In a leave-one-out cross validation 80% of the predatory mite samples and 76% of the oribatid mite samples were correctly classified into their respective age class. Predatory mite assemblages showed a tendency for an association with plant species according to the CAP results. Roughly 48% of the predatory mite samples were correctly classified into their respective plant species group.
Canonical correspondence analysis (CCA) revealed that the oribatid mite assemblage was best explained by soil organic carbon, C:N ratio, water content and microbial carbon while the predatory mite assemblage was best explained by soil organic carbon, total density of Collembola and water content.

O14 – Multiple benefits of grassland restoration: enhancing biodiversity, soil carbon sequestration and other ecosystem functions

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Across Europe grassland systems are an important form of land use for husbandry, for the biodiversity they harbour and for their soil carbon storage potential. The importance of grasslands is well reflected in agri-environment policy in Europe. This policy aims at grassland management that stimulates plant and other biodiversity, as well as the delivery of ecosystem services of which soil carbon (C) storage is a notable in relation to combatting global change. In our work we aimed to test whether biodiversity restoration management that also promotes the net accumulation of C and nitrogen (N) in soil. We tested this using a long-term field experiment which comprised different levels of fertiliser use and plant seeding and vegetation development in response to that for 16 years, and on top of that the establishment of different densities of the legume species *Trifolium pratense* densities during the last 2 years. We determined the pools of C and N in vegetation and the rates of accumulation of C and N in soil. Moreover in order to unravel the mechanisms underlying changes in soil C and N accumulation rates in relation to diversity restoration management we measured ecosystem respiration, soil enzyme activities and soil structure. Our data revealed that soil C and N accumulation increased in response to the long-term biodiversity restoration practices of cessation of fertiliser use and sowing of species mixtures, especially when these treatments were combined with the promotion of *Trifolium pratense* abundance. The increase in soil C and N accumulation rates was associated with elevated content of soil organic matter, reduction in the rates of ecosystem respiration, and improvement in soil structure. In contrast the cessation of the use of mineral fertiliser reduced the amount of C and N stored in vegetation. Our results demonstrate that long-term diversity restoration practices can yield significant benefits for soil C storage when they are combined with enhancement of key species. We also found that these management practices resulted in additional ecosystem benefits such as soil N storage, organic matter build up and improved soil structure. It is hence clear that these soil based ecosystem services are interrelated and can be managed by thorough understanding of the dynamic interactions between plants and the soil (sub)system.

O15 – Dual analysis of stable isotope ratios ($^{15}N/^{14}N$ and $^{13}C/^{12}C$) of selected plant species and associated soil fauna taxa in grassy arable fallows

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The $\delta^{13}C$ and $\delta^{15}N$ signatures of leave/shoot and root material and several soil animal taxa in six grassy arable fallows of different age were investigated in a factorial design with the factors'plant species' (legume: *Medicago sativa*, herb: *Taraxacum officinale*, grass: *Bromus sterilis*) and 'age class' (young: 3-4, old: 13-16 years). Three plots were selected randomly at each fallow. In April 2009, within each plot the above ground material of six *M. sativa*, *T. officinale* and *B. sterilis* plants were harvested and the trimed plants (3 cm shoot/ leave material and roots) were extracted with their associated soil using steel cylinders. After head extraction of the soil animals combined measurements of $\delta^{13}C$ and $\delta^{15}N$ signatures (soil animal taxa, roots, leave/shoot material) provided insights into the soil food web structure of the investigated fallows.
The main results were: (i) due to the higher $\delta^{13}C$ signatures of the plant material (shoot/leave, root), the juvenile Julidae and the ant taxa *Myrmica* sp., *Lasius* sp. and *Solenopsis* sp. in the young fallows compared to the old fallows we were able to identify a potential "separated" food chain within our experimental design; (ii) surprisingly, the oribatid species *Philogalumna crassiclava* has to be assigned to the predatory taxa (presumably feeding on nematodes) with a maximum $\delta^{15}N$ value of 8.60 ‰ in the young fallows (7.57 ‰ in the *Taraxacum* samples); (iii) the staphylinid genus *Xantholinus* was the top-predator within the investigated soil food web with a maximum $\delta^{15}N$ value of 10.56 ‰ in the *Taraxacum* samples.

P1 - A public earthworm sampling campaign: Results and experiences from "Die Frühlingsforscher" a public (citizen) science platform and network

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The public science platform „Die Frühlingsforscher" by arte started in spring 2012 for the first time in Germany. Four citizen science actions were provided on the German platform. The second one running from March 28 to Mai 15 was on earthworm communities.
The platform worked like a social network. Participants were able to register and to apply for any provided action. The website gave a lot of interesting news on nature in spring and a little bit more focused on the organisms heading the four different actions. Within the earthworm action printable pdf-files containing (1) a description of the procedure for a simplified mustard-extraction, (2) a identification key for ecological groups, and (3) a form to take to the field to fill in information about the site and the sampling results. Mostly gardens and loans were investigated by the participants ranging between 4 and nearly 500 individuals per m^2 covering all ecological groups. The average number was about 100 individuals per m^2. In total about 50 participants posted 65 observations. This number is quite low. We will draw conclusions for any future citizen science activity and take a look on the French sister action.

P2 – EDAPHOBASE - a new data warehouse for soil organisms

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EDAPHOBASE (www.edaphobase.org) is a database, which collects most comprehensive information for some highly relevant soil animals (Nematoda, Enchytraeidae, Lumbricidae, Gamasina, Oribatida, Chilopoda, Diplopoda, Collembola). The database combines data on the species, their collecting locality and ecological parameters. At present, we focus on Germany and neighbouring countries, but it is intended to incorporate data from other European countries in the future. Data were derived from publications and collections from German museums and research institutions but also from unpublished results of field studies (theses, reports).
The data comprise up-to-date taxonomic thesauri, geographical references, soil composition, vegetation, meteorological data, sampling and extraction methods, quantities of collected organisms, identification methods, preparation techniques, and behavioural data. The data quality in EDAPHOBASE is guaranteed by critical evaluation of the data by ecological and taxonomic experts prior to data input.
EDAPHOBASE offers a wide range of tools for data inclusion (client, GIS-tool, semi-automatic literature analysis) and data exploration. Simple queries are possible as well as more sophisticated analyses of different data groups concerning, e.g., geographical distribution or preferences and tolerances with regard to specific niche parameters or effects of anthropogenic perturbation. Since EDAPHOBASE covers the long history of investigation on soil organisms it will be possible to reveal major ecological alterations as a reaction to modifications in land-use techniques or effects of climate change.
EDAPHOBASE is part of the Global Biodiversity Information Facility (GBIF) network.

P3 – Laboratory experiments on nematodes from mofette fields (natural carbon dioxide springs) reveal species-specific adaptations

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Focusing on naturally occurring environmental changes, we are investigating responses of soil nematodes using the example of mofette fields. In mofette fields, CO_2 is ascending upwards froma natural geogenic source, diffusing and altering the atmosphere in the soil layers. In consequence, a small scale mosaic of different CO_2 concentrations is found around the vents with normal conditions only centimetres away from those predicted in climate change research to highly elevated CO_2 concentrations of up to 100 %. Hypoxia and soil acidity are further abiotic stressors in these environments. Reduced or absent plant growth, species losses and changes in biotic composition are observed in spots of elevated CO_2 concentrations. Moreover, we detected changes in the population distribution of bacterial-feeding nematode species *Acrobeloides nanus* (prevalent in soil with concentrations of up to 2 % CO_2, absent in spots exceeding 20 % CO_2) and *Acrobeloides* cf. *buchneri*

(infrequent up to 2 % CO_2, prevalent from 20 to 60 % CO_2). In laboratory experiments we were now investigating the hypothesis that CO_2 is triggering the observed distribution patterns.
We investigated the impact of increased CO_2 and concomitantly decreased O_2 on viability, activity and reproduction rate of the two nematode species in dependence of life stage (adults, juveniles and eggs) and time of exposure (21 hours or 5 days). We hypothesized a better adaptation to increased CO_2 concentrations for *A.* cf. *buchneri.*
Surprisingly, we found that representatives of both species survived a 5-day exposure in 100 % CO_2. The difference between the species lies in the ability to stay active: whilst individuals of *A. nanus* were inactive under 20 % CO_2, *A.* cf. *buchneri* stayed active and laid eggs. This gives *A*. cf. *buchneri* an advantage over *A. nanus* in spots with elevated CO_2.
From these laboratory results we conclude that CO_2 is at least one of the factors influencing the distribution of *A*. cf. *buchneri* and *A. nanus* in the field. At the moment we aim at investigating further possible factors such as soil acidity.

P4 – Increasing soil methane uptake along 120-year afforestation chronosequence is driven by soil moisture

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Methanotrophic bacteria in upland soils are the only biological sink for atmospheric methane (CH_4). Forest soils generally are larger sinks for atmospheric methane than pastures, but the mechanisms involved are not well understood to date. Soil gas diffusivity often is higher in forest soils than in pasture, which may favor CH_4 oxidation because this process often is diffusion-limited. Also, nitrogen inputs to forest soils may be lower than in pasture.. Afforestation can therefore increase soil methane uptake, but the few studies available indicate that this process is slow, for reasons not well understood to date. Here we report soil CH_4 uptake along an afforestaion chornosequence with Norway spruce (*Picea abies* L.) established in extensively grazed subalpine pasture. We measured soil CH_4 uptake in situ throughout a growing season, and found a progressive increase of the soil methane sink with forest stand age. We further labeled intact soil cores with 14 CH_4 in the laboratory and mapped the spatial distribution of methane uptake using an auto-radiographic technique. Soil moisture and soil porosity data indicated that the increase in soil CH_4 uptake in the older forests was primarily driving by reduced soil water content. Likely reasons for the drier soils were increased interception and increased evapotranspiration in old forest stands. As a consequence, water-filled pore space decreased and diffusion of atmospheric CH_4 down the soil profile to the methanotrophically active soil layer was facilitated. This mechanism contrasts alternative explanations including altered soil N status, altered soil structure or shifts in the methanotrophic community structure, although these factors also might be at play. Our findings further imply that the currently dramatic increase in forested area in alpine regions increases CH_4 uptake in Alps.

P5 – Fertilisation equalises microbial community structure of grassland differing in plant functional group composition

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Soil microbial communities are key players for ecosystem functioning, such as decomposition and nutrient cycling. They strongly depend on plants, since plants provide carbon and nitrogen through rhizodeposition. To improve soil and hence productivity of grasslands they are commonly fertilised. In this study we examined the effect of fertilisation and different proportion of functional plant groups on microbial communities.
We implemented a two-factorial design including two fertilisation treatments (non-fertilised and NPK fertilised) and three levels of swards differing in the proportion of plant functional groups. The different swards were established by applying herbicides prior to the experiment, targeting monocotyledons (monocots reduced) or dicotyledons (dicots reduced), to a semi-natural moderately species rich grassland. PLFA (phospholipid fatty acid analysis) was used to determine the microbial community composition in the soil.
Microbial community structure in non-fertilised swards differed between control and monocots reduced plots but not between control and dicots reduced plots, with the difference being mainly due to the fatty acids 18:2ω6,9 as a marker for fungi, and *a*15:0, as a marker for gram positive bacteria. Fertilisation eradicated differences in microbial community structure between the swards, but fertilised plots generally differed significantly from the non-fertilised plots with the amount of total PLFAs being significantly higher in non-fertilised as compared to fertilised plots. Further, the fungi-to-bacteria ratio decreased significantly from monocots reduced to dicots reduced swards with the control being in between. Higher fungal-to-bacterial ratio and amount of total PLFAs in non-fertilised plots suggests that fertilisation favours microbial communities of lower carbon use efficiency.

P6 – Earthworm communities in grasslands in Central France - Effects of different management practices

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In a permanent grassland in the French Massif Central five different management practices and their impact on earthworm communities were compared in a field sampling in April 2011. Abundance, biomass and species richness of earthworms were measured and the effect of mowing and rotational grazing by sheep or cattle at a low and high stocking density was investigated. Species richness was not affected by the grassland management as ten to twelve different taxonomic categories occurred under each management practice. Anecic earthworms, particularly Aporrectodea giardi, were positively affected by grazing, even at the high stocking density of cattle. In the studied context, earthworms did not differ between sheep and cattle grazing. Epigeic and endogeic earthworms did not show a consistent tendency in their reaction to the altered management. Moreover, the present study underlined the requirement for further investigation of the interactions within the soil food web and between soil organisms and plants.

P7 – Interactions between a herbicide, earthworms and mycorrhiza in a *Trifolium repens* model ecosystem

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Earthworms and arbuscular mycorrhizal fungi (AMF) are important components in temperate ecosystems, influencing nutrient cycling and overall ecosystem functioning. The use of total herbicides containing the active ingredient glyphosate in agricultural and private use is rising worldwide, however not much is known on possible side effects on important soil organisms like earthworms or AMF. Here we investigated, whether the application of the widely-used herbicide Round up® influences (i) the activity of the anecic earthworm *Lumbricus terrestris*, (ii) the colonisation of the legume *Trifolium repens* with the AMF *Glomus mosseae* and (iii) whether earthworms and/or AMF influence potential leaching of glyphosate and its main metabolite AMPA after a simulated heavy rainfall.
The experiment was conducted in an experimental greenhouse at the University of Natural Resources and Life Sciences Vienna (BOKU), Austria. We used 24 plastic pots (volume 20 l, further called mesocosms), filled with steam-sterilized field soil (Haplic Chernozem, silty loam) mixed with quartz sand. Mesocosms were planted with 19 *T. repens*individuals in a regular pattern. Three factors were replicated three times in a full-factorial design: factor earthworm (two levels: addition of 4 adult individuals of *L. terrestris*vs. no earthworms), factor AMF (two levels: inoculation with 25 g of *G. mosseae*vs. no AMF) × factor herbicide (two levels: 179 ml m^{-2} herbicide application vs. no herbicide). One week after the herbicide application, the mesocosms were subjected to a rainfall of 40 l m^{-2}. Preliminary results suggest that considerable concentrations of the herbicide and its metabolite can be measured in the soil leachate after the simulated rainfall. However, earthworms and/or AMF seemed to have little influence on herbicide leaching.

P8 – Interactions between earthworms, mycorrhizal fungi, plants and aphids revealed by stable isotope labelling of earthworms

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Both earthworms and mycorrhizal fungi (AMF) have been shown to interact with each other affecting the nutrition and chemical quality of plants - sap sucking insects are hypothesized to respond to different plant quality. In order to test this hypothesis, we set up a factorial greenhouse mesocosm experiment consisting of a stand of the legume *Trifolium repens* and their associated aphids (*Aphis fabae*) where we manipulated the factor earthworms (addition of *Lumbricus terrestris vs. no earthworms*) and AMF (inoculation with *Glomus mosseae vs. no AMF*). Before added to the mesocosms, earthworms were labelled with stable isotopes by cultivating them in soil substrate amended with ^{15}N-ammonium nitrate and ^{13}C-glucose. We wanted to know whether (i) isotopic signals would be passed on from the labelled earthworms to surface castings, plants and aphids, (ii) how much these compartments differ in their incorporation of stable isotopes. There was a significant difference in isotope enrichment across the tested organismic compartments measured seven days after the introduction of earthworms into the mesocosms; isotope incorporation decreased from casts to aphids. Generally, this indicates that plants utilize nutrients excreted via earthworm casts or mucus and incorporate the labelled nutrients into roots and leaf tissue and even pass it on to aphids. AMF tended to affect stable isotope incorporation into the study organisms: belowground (earthworms, casts and roots) the isotope signature was lower in the presence of AMF, aboveground (leaves and aphids) isotope signature was positively affected by AMF. Our study demonstrates that *in situ*isotopic labelling of earthworms can help deciphering functional links between earthworms, AMF, plants and aphids.

P9 – Litter and root species diversity on the structure soil animal food webs of deciduous forests

Diana Grubert[1], Sarah Herzog[1], Christina Lödige[1], Klaus Schützenmeister[1], Christian Ammer[1], Rolf Daniel[1], Dirk Gansert[1], Dietrich Hertel[1], Lars Köhler[1], Andrea Polle[1], Olaf Butenschoen[1], Stefan Scheu[1]

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The effect of biodiversity on soil ecosystem functioning and stability still is poorly understood. In particular, knowledge on the influence of above- and belowground resource quality and diversity on soil microbes and soil animals, controlling vital ecosystem processes such as carbon and nutrient cycling, is lacking.
I will present first results of SPLIDRHEX, the **Sp**ecies **L**itter **I**dentity and **D**iversity effects on the **Rh**izosphere of trees - **Ex**periment established in spring 2011 within the framework of the “Functional Biodiversity Research Cluster of Excellence” at the University of Göttingen. Plant and litter species richness (0, 1, 2, 4) were manipulated in combination with deciduous tree species diversity and identity (beech, ash, maple, lime) allowing the separation of the effects of litter from that of roots. Litter species represented fast (ash and lime) and slow decomposing species (beech and maple) and tree species represented those with arbuscular (ash and maple) and ectomycorrhizal symbionts (beech and lime). A total of 304 plots (180 x 210 cm) each containing 30 tree individuals were established in four blocks. In autumn 2011 soil samples were taken at each plot and analyzed for soil fauna community composition and microbial biomass and activity. Moreover, we analyze natural stable isotope ratios (^{13}C/^{12}C, ^{15}N/^{14}N) of litter, roots, soil and abundant soil animal species to disentangle the relative contribution of above- and belowground resources for soil food web structure.

P10 – Nano, bulk or complexed iron: what to use for soil remediation?

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Iron has a long tradition in soil remediation, due to its reductive properties and its sorption capacity. The latter substantially increases when iron is present in nanoparticular form. Since at the same time the costs of remediation are considerably reduced, nano-iron has been increasingly used for remediation purposes. In an earlier study we had found that nano-iron had a limited capacity to reduce the toxicity of cadmium to plants (*Lepidium sativum, Arabidopsis thaliana*) and caused avoidance by earthworms (*Eisenia fetida*), even when applied in uncontaminated soil. The tests also rendered *A. thaliana* way more sensitive than *L. sativum*. In a second series we tested the impact of iron powder and iron fertilizer on both plant species, earthworms and the toxicity of cadmium to them. Highly concentrated fertilizer is highly toxic to both plants and earthworms and thus cannot be used for remediation purposes. Iron powder did not reduce the toxicity of Cd to either *L. sativum* or*A. thaliana*, on the other hand it was not avoided by earthworms and somewhat reduced their avoidance of Cd soil. Thus, the choice for remediation seems to resemble the one between Scylla and Charybdis.

P11 – The conservation of soil nucleic acids by freeze-drying for 454 sequencing analysis of soil microbial communities

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The study of soil nucleic acids is still dependent on a frozen soil sample transport especially when dealing with RNA. The fast decay of nucleic acids due to exonucleases has to be prohibited. Widely approved is the snap freezing of soil samples in liquid nitrogen and their constant cooling to -80°C (RNA) and -20°C (DNA) until extraction. Often, the soil sampling is done far away from the processing lab and the organization of a reliable cooling chain during transportation is very costly and complicated.
Here, we report the alternative application of freeze-drying for the conservation of nucleic acids in soil samples. Freeze-drying efficiently removes water by sublimation from snap frozen soil samples. The frozen water never enters the liquid state and degrading enzymes are reversibly inactivated. Freeze-drying of samples is well established for enzyme and fatty acid analysis. Contradicting results have been published for the analysis of nucleic acids from freeze-dried soil and tissue material using DGGE, T-RFLP and microarrays. In this study we analyzed the effect of freeze-drying and subsequent storage at 4°C or room temperature on the soil nucleic acids by 454 GS FLX sequencing of bacterial and fungal communities. We compared two storage times of 1 and 7 days until extraction. The results from this study provided an evidence to use freeze-drying for the conservation of nucleic acids in soil, which have an important implication in transporting samples across continents.

Session 31 – Spatial patterns and ecological processes

Chairs: Kerstin Wiegand, Katrin Meyer

O1 – Environmental and spatial determinants of the soil oribatid mite assemblage of a dry grassland

Stefanie Lauke[1], Stefan Hempel[1], Matthias Rillig[1], Tancredi Caruso[1]

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In the framework of the debate on niche vs. neutral processes of community assembly, we analysed the oribatid mite assemblage of a dry grassland in the nature reserve of Mallnow (Brandenburg, Germany). The study was performed at a small scale (15 x 15 m plot) along a steep gradient in important soil parameters (pH, water% (s.d.w.), C and N) using a spatially explicit sampling design. The total variance of the species matrix was partitioned into three sources: 1) unique effect of the environment; 2) spatial patterns independent of environment (autocorrelation); 3) spatially structured environmental effects. Measured environmental variables (1) and spatial autocorrelation (2) plus the shared variation between these two (3) accounted for 55% of the total variance in species composition. Out of the 55%, 35% can be explained by pure spatial autocorrelation (i.e. after accounting for environment), 15% by pure environmental variables (i.e. after accounting for spatial autocorrelation), and 5% by spatially structured environmental variables. Specific tests performed on environmental variables showed a significant effect of water ($p = 0.01$), the content of C and N was only marginally significant ($p = 0.05$), while no effects were detected for pH and C:N ratio. These results show that spatial mechanisms independent of the measured environmental variables do play an important role in shaping community patterns of oribatid mites. On the other hand, a clear and spatially independent effect of environmental variables was also detected. Thus, the study shows the synergistic roles of neutral and niche processes in community structuring and contributes to disentangle their relative roles in the assembly of soil communities.

O2 – Spatial and environmental determinants of AM fungal communities and their associated plants in a semi-arid grassland

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Arbuscular mycorrhizal fungi (AMF) associate with the majority of land plants, yet the actual extent of AMF diversity, its drivers, and its interrelationship with the plant community remain underexplored. With respect to the neutral-niche debate in community assembly, we analyzed AMF communities in the soil of a semi-arid grassland and associated plant communities. The study area is located in a nature reserve near Mallnow (Brandenburg, Germany). The area offers the rare opportunity of studying steep gradients in soil properties (pH, soil moisture, plant-available phosphorous, soil carbon and nitrogen) on a very small spatial scale on plots the size of 15x15m. The plant community is very diverse, yielding a total of 68 different species within the three study plots. A variance partitioning analysis on the plants revealed that only 2% of the variation in community assembly is explained by the soil variables. The majority of the variation (14%) is caused by pure spatial parameters. Spatially structured environment accounted for 9% of the variation, giving a total of 25% variation explained. Null model analysis showed that biotic interactions might be an important driver of the community. The AMF community was analyzed using DNA based methods (454-pyrosequencing), revealing an unexpectedly high diversity. Further analysis will be implementing the generalized mixed Yule-coalescent (GMYC) model to objectively determine OTUs within the AMF community. Using these results we hope to shed further light on the relative role of niche and neutral processes structuring fungal communities and their plant associates.

O3 – Estimating genotypic diversity in populations of dimorphic clonal plant species by point pattern statistics

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[2]EMAU Greifswald, Greifswald, DE

Populations of clonally growing plants possess a high proportion of genetically identical individuals, with usually far less genotypes than individuals. Assessing the number of genotypes by genetic analyses is still more expensive and time consuming than mapping of the stands. Thus, estimating clonality by spatial statistics may be an alternative if a plant shows sexes or flower morphs.

In the *Populus euphratica* forests of northwestern China, the degree of clonality varies strong among populations as a result of different ground water supply. This dioecious tree allows to use male and female trees as markers, since all individuals sharing one genotype must be of equal sex. Departure from a complete random spatial distribution of sexes indicates the presence of clones. Our goal is to estimate the number of genotypes from spatial patterns in flowering stands.

Methodologically, this is cluster density estimation for multitype cluster point processes. The estimator used is designed in a way that it is fast to compute and that we need only a minimum of assumptions about the underlying pattern generating process. First, we apply mark connection functions to estimate the spatial extension of groups of individuals sharing the same genotype. Then, we estimate the number of paired neighbours sharing the same genotype. Finally, we conclude on the number of genotypes or clusters in a stand, assuming a distribution model for the cluster size, i.e. the number of individuals sharing the same genotype.

Since about 20% of all flowering plants grow clonally and display some kind of sex marker (such as dioecy, heterostyly, or gynodioecy), this method has a great potential for a quick assessment of the degree of clonality in populations of dimorphic plants.

O4 – Interactions between spatial point processes and line processes in ecology

Daniel S. Esser[1], Katrin M. Meyer[1], Martin Schlather[2], Kerstin Wiegand[1], Johan H. J. Leveau[3]

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Structural elements of the environment can affect the spatial distribution of organisms. We developed a new statistical method to correlate the distribution of points to linear structures in space. Our method is based on point pattern summary statistics such as the mark-correlation function $g_{12}(r)$. These statistics yield important information about the scales of interaction between individuals of a target species and other point-like elements in their neighborhood, e.g. individuals of a second species. Our new method determines if the point pattern is influenced by the line pattern, identifies the range over which these effects act and if they are of an attracting or repulsing nature. It will help ecologists to better understand how individuals interact with linear structures like roads, streams, hedges or other types of narrow ecotones. We will illustrate this new method by showing how the distribution of bacterial cells on leaves is affected by linear structures of the leaf surface, i.e. leaf veins and grooves between epidermal cells.

O5 – The role of heterogeneity in spatial plant population dynamics

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Recent evidence suggest that plant population dynamics and pattern formation can be influenced by spatial heterogeneity. For example, growth patterns may be modified by spatial heterogeneity in soil properties or topography. To disentangle the effect of heterogeneity and individual-individual interactions on spatial tree growth patterns, we analysed data of a stand comprising almost 15 000 trees in the National Park Hainich (Thuringia, Germany). This spatially heterogeneous stand is dominated by beech with admixed hornbeam, ash, maple and elm. For each tree several marks (e.g. position, species identity, dbh) are known from measurements in 1999 and repeated in 2007. Direct and indirect indicators for site productivity (e.g. soil properties, indicator values, estimated biomass) and heterogeneity were obtained to characterise critical scales of habitat heterogeneity influencing tree patterns in different growth groups (dbh classes). To analyse growth patterns taking individual-individual interactions and individual-environment interactions into account, we used pair-correlation-functions and nearest neighbour-functions. First results indicate that species differ in their scale and reaction towards heterogeneity.

O6 – How does the interplay of ecological processes determine succession? A simulation study for the Eifel NP under different forms of land use

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Semi-natural grasslands belong to the most species-rich biotopes in Germany but suffer strongly from land use change. After abandonment of grasslands, secondary succession on a certain site is difficult to predict due to the complex interactions of the manifold processes. In order to support decision support when managing semi-natural grasslands in the Eifel National Park, we built the GraS-Model (Grassland Succession Model) integrating the succession of the herbaceous as well as the tree layer using a multimodeling approach. The cover of grasses and herbs are simulated in a compartment model, whereas trees are modelled individual-based. Both submodels work and interact in a spatially explicit, raster-based landscape.
Pattern-oriented model evaluation revealed that the model is able to emulate successional patterns observed in the field. Neighbourhood interactions, the inhibition of wood encroachment by the herbaceous layer and the protection of seedlings from browsing ungulates by thorny bushes triggered emerging patterns.Forest encroachment on the Dreiborner Hochfläche was most strongly delayed by non-interference with the given high abundance of red deer (apart from mowing), whereas grazing by bison promoted a diverse landscape mosaic.
The presented dynamic, spatially-explicit model allows for a highly detailed projection of secondary succession on semi-natural grasslands including the influence of initial vegetation composition, neighbourhood interactions and ungulate browsing. Without such a model, an expert might have difficulties in judging the weight of the mutually interacting processes at different scenarios, and predicting the course of succession for a specific site becomes a difficult task. The developed model integrates many mutually interacting processes of secondary succession providing valuable support in decision making for stakeholders.

O7 – A landscape of fear or a sea of opportunities: the spatial relationship between arthropods and vegetation in cereal farming systems

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The distribution of non-predaceous arthropods in cereal fields may be driven by density-dependent (predators) and –independent (vegetation) factors. Agricultural management affects both invertebrate densities and structural habitat conditions, but our knowledge about the impact of different management systems on the spatial relationships between individuals from different trophic levels remains very limited. Arthropod predators play an important role in biological control and the decoupling of spatial predator-prey associations may reduce the provision of pest suppression services in organically managed cereal fields.
In this study, we used replicated conventionally and organically managed barley fields of different transition age to investigate the effects of agricultural management on the spatial relationships between potential prey, generalist predators and plants. Organically managed cereal fields had a higher weed

cover compared to conventionally managed arable fields and the spatial distribution of weeds differed between farming systems. These man-made habitat changes to the vegetation altered the spatial relationships between predators and potential pest and non-pest prey in cereal fields.
We conclude that active control of crop plant physiognomy by growth hormones and the suppression of weeds by herbicides indirectly alter spatial relationships between predators and prey. Our results emphasise the need for a more mechanistic understanding of the effects of land-use on the formation of spatial patterns and species interactions, especially under environmental change and the ongoing loss of biodiversity.

O8 – Optimization of biodiversity experiments by spatial analysis of arthropod distribution patterns

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We developed a method to quantify spatial autocorrelation effects at arthropod species level, regarding arthropod communities at the plots of a biodiversity grassland experiment (Jena Experiment).
Due to spatial proximity of plots in the common regular plot arrangement of biodiversity experiments, plot-specific arthropod communities of neighbouring plots influence each other, because individuals spill over into adjacent plots. This causes data noise that blurs the analysis of arthropod-plant relationships.
We used herbivorous arthropod species as model objects to quantify these spatial effects. Key assumption is that a plant-specialised species occurs on plots only, where at least one of its forage plants is sown. This allows classifying, whether an individual is present on a plot because of its relatedness to the sown grassland community, or due to adjacencies to another plot's community. Plot distances and herbivore abundances were used for spill-over calculation.
Spill-over signals were clearly visible. At least 16% of all caught herbivore species were detected to spill over into adjacent plots. By using classification tree analysis, especially Random Forest, two types of spill-over ranges ('wide' and 'nearby') could be characterised by sets of specific arthropod traits. Therefore, type 'wide' is characterised through (1) a high number of annual reproduction cycles, (2) a high degree of monophagy, (3) an early regular adult occurrence during the year, and (4) feeding on grass species.
Arthropod data based results of biodiversity experiments may or may not change strongly with data noise reduction mediated through abundance spill-over detection. But the potential reduction provides the accentuation of meaningful signals and data contrasts. This improves the analysis of such financially, temporally, and spatially extensive experiments, in particular concerning plant-arthropod relationships as one of the main interests of recent and future biodiversity experiments.

O9 – From the cradle to the grave - genetic analysis reveals human-mediated long-distance dispersal in *Trifolium micranthum*

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Even though various forms of human transportation have been observed to provide long-distance dispersal of seeds, it has only scarcely been addressed how this contributes to the spatial dynamics of established (meta)populations on the regional scale. In this contribution, I will demonstrate the role of man in shaping gene flow among distant populations of a small grassland species, *Trifolium micranthum*. In western Belgium, this rare legume is found only (i) in coastal dune grasslands that are managed for conservation, and (ii) as a lawn weed on war cemeteries of the British Commonwealth. Some of these cemeteries (with *T. micranthum*) are situated along the coast, lying as close as 30 metres to the dune populations. Nonetheless, genetic analysis through AFLP revealed that populations are not related by geographic proximity but by management instead: i.e., dune grasslands (cf. livestock) and lawn cemeteries (cf. mowing machinery) form different genetic clusters. Lawn management of the cemeteries has led the species to bridge over 30 kilometres, most likely through the exchange of seeds with composted lawn litter. Further analysis nevertheless indicated limited genetic admixture to have taken place among dune grassland and cemetery stations. Human management is thus accountable for the realization of gene flow among essentially remote gene pools. The long-distance dispersal events revealed here are likely to play a significant, but fairly cryptic role in the local or regional dynamics of many native species, including those that are more common or better-dispersing.

O10 – Alternative mechanisms alter the emergent properties of self-organization in mussel beds

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Theoretical models predict that spatial self-organization can have important, unexpected implications by affecting the functioning of ecosystems in terms resilience and productivity. Whether and how these emergent effects depend on specific formulations of the underlying mechanisms is an often ignored question. Here, we compare two alternative models of regular spatial pattern formation in mussel beds that have different mechanistic descriptions of the facilitative interactions between mussels. The first mechanism involves a reduced mussel loss rate at high density due to mutual protection between the mussels, which is the basis of prior studies on pattern formation in mussels. The second mechanism assumes, based on novel experimental evidence, that mussels feed more efficiently on top of mussel-generated hummocks. Model simulations point out that the alternate model produces very similar types of spatial patterns in mussel beds. Yet, they predict a strikingly contrasting effect of these spatial patterns on ecosystem functioning, in terms of productivity and resilience. The first model, where high mussel densities reduce mussel loss rates, patterns are predicted to strongly increase productivity and decrease the recovery time of the bed following a disturbance. When pattern formation is generated by increased feeding efficiency on hummocks, only minor emergent effects of pattern formation on ecosystem functioning are predicted. Our results provide a cautionary warning against predictions of the implications and emergent properties of spatial self-organization, when the mechanisms that underlie self-organization are incompletely understood, and not based on experimental study.

O11 – Developing robust field survey protocols in landscape ecology: A case study on birds, plants and butterflies

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Sustainable land management demands scientists to provide baseline data, for example on species distribution patterns across entire landscapes. Restrictions in resources like money, man-power and time pose limits on the affordable sampling effort, both with respect to the number of sampling units surveyed and the number of surveys per unit. In this study, we examined the trade-off between survey intensity and number of survey sites through a case study in Central Romania. We surveyed 35 sites measuring one hectare each for plants, birds and butterflies. We performed vegetation surveys in three 10 m² plots and ten plots of 1 m² in each site. We used standard point counts for birds, and standard Pollard walks for butterflies, and for both groups we conducted four repeated surveys. For each group, we then tested the effects of correlating a subset of the dataset with data from the full survey effort, focusing on species richness, species turnover and species composition. We also ran a Cohen's power analysis and we performed simulations to determine the minimum detectable effect of a linear model for bird species richness in response to landscape heterogeneity, as a specific example that was relevant for our study area. Correlations between results of reduced sampling effort and results of full survey effort showed that in many cases, a reduced survey effort still reflected patterns of the true biodiversity well. The power analysis with simulated data showed an exponential decrease of minimum detectable effect with increasing sample size. The marginal increase in statistical power per additional sampling unit was increasingly low for a higher number of plots or repeats. Our findings suggest that if the goal is to assess broad patterns in biodiversity, survey effort often can be relatively low per site, as long as there are many sites. However, this conclusion holds only for organisms with relatively high detectability and abundance – rare species will typically require a much higher survey effort. We recommend that more landscape ecologists conduct pilot studies before scaling up their work, because this allows for a more efficient research design.

O12 – Climate-driven landscape patterns in pasture-woodland landscapes of the Swiss Jura

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In the last century, multi-functional pasture-woodlands have declined in Western Europedue to a segregation of land use into large patches of intensively used grasslands and forests. Landscape heterogeneity and habitat diversity declined from small-grained heterogeneous patterns towards more monotonous and mono-functional landscapes with widely known negative consequences for biodiversity. Nowadays, silvopastoral systems are among the most promising approaches for sustainable management of mountain areas world-wide.

In the Swiss Jura Mountains, wooded pastures still represent a traditional form of a semi-natural landscape. In combined experimental and (long term) simulation studies it was shown that these ecosystems are highly sensitive to land use and climate change due to the complex interactions which drive the dynamics within a grassland-forest-mosaic. Simulation studies applying the spatially explicit compartment model of wooded pastures WoodPaM to wooded pastures in the Parc Jurassien Vaudois encountered the relative importance of grazing pressure and climatic stress for trees to survive in this multi-factorial environment. Tree species composition in pastures shifts from spruce *(Picea abies)* to beech *(Fagus sylvatica)* and pine *(Pinus sylvestris)* following the shifting dominance of browsing, long winters or drought as environmental factors. Consequently, the ecology of beech and pine lead to landscape patterns that differ from those formed by spruce in the past. Tree species specific traits, like regeneration ability under harsh climate and in the shade of a closed canopy, as well as resistance to browsing, evoke grassland-forest mosaics, which are very distinct from the present diverse mosaic of small stands of spruce and isolated trees in the pastures: Dependent on the degree of climate warming clumped patterns of closed beech forests emerge, which are segregated from open grassland, or the landscape is dominated by (light) pine forests.

We conclude that climate adaptive management that aims at the maintenance of semi-open landscapes and its inhabitated biodiversity is a difficult and complex task because these ecosystems might respond qualitatively different in the face of changing environmental conditions.

O13 – Mammalian herbivores as landscape designers of an African savanna

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African savannas and their people heavily rely on resources provided by an intact ecosystem. Mammalian herbivory is one of the major factors regulating savanna ecosystems and can strongly alter woody and grassy components. However, research quantifying and comparing the impact of diverse domestic and wild mammalian herbivore assemblages and their densities on the vegetation is rare. In the Kruger National Park (KNP) and adjacent communal grazing lands we assessed the vegetation under different grazing and browsing regimes in a close-to-natural savanna versus communal grazing land. We studied woody plant species composition and structure under browser presence and absence. We additionally analysed herbaceous vegetation and soil properties to understand the role of grazer densities and assemblage types.
We found that herbaceous species richness was higher on communal farmlands compared to protected areas inside KNP, as was forb cover. The lowest Shannon Wiener diversity index was found under mono-specific grazing at both wildlife and livestock sites. Grass leaf nutrient content was significantly higher and annual grass species were less abundant under multi-species wildlife and livestock herbivory. Inside KNP, the mono-specific site showed the highest density of bushes and small trees. In contrast, bush density at the livestock sites was found to be higher while small tree density was significantly lower under multi-species compared to mono-specific herbivory.
Our research showed that certain grass species were strongly resistant against high mono-specific grazing pressure. Multi-species herbivory in contrast decreased pressure on herbaceous vegetation, enhanced biodiversity and improved grass quality. Bush and small tree growth could efficiently be suppressed by multi-species herbivory. Different herbivore assemblages show strong impacts on vegetation and soil conditions, hence, play an important role as landscape designers in African savannas.

P1 – Spatial patterns and competition of *Streblus macrophyllus* trees in a tropical evergreen forest stand, Vietnam

Hai Nguyen[1]

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Streblus macrophyllus is a shade–tolerant, mid-storey tree species common to tropical evergreen forests in Vietnam. However, the ecology of *S. macrophyllus* is poorly known. We used spatial point pattern analysis to describe the spatial arrangement of tree individuals within forest communities dominated by *S. macrophyllus*. From these patterns, we derive hypothesis on the ecology of this species. All tree individuals with diameter at breast height (dbh) larger than 2.5 cm in a 1ha plot were mapped and measured. We divided trees into three life-history stages (juvenile: dbh < 5 cm, premature: 5 ≤ dbh < 10 cm and mature: dbh ≥ 10 cm). The overall pattern of this species was a regular distribution up to scales of 1.5 m. Juvenile and premature trees were aggregated but mature trees were regular at scales of up to 2 m. This indicates clumped regeneration and subsequent competition within *S. macrophyllus*. Repulsion was observed between mature and premature stages, implying further evidence of density dependent mortality within *S. macrophyllus*. Being the most abundant species, spatial pattern of *S. macrophyllus* strongly affected the patterning of the whole plot. Overall association with remaining species showed marginal negative interaction. However, contrasting *S. macrophyllus* mature trees against life-history stages of remaining species indicated a clear repulsion effect between mature *S. macrophyllus* and juvenile and premature trees of the remaining species, while mature trees were independent of each other. Overall, we conclude that juvenile and premature trees in *S. macrophyllus* –dominated forests experience competition while competitive effects are of minor importance for trees that survive into the adult stage.

P2 – The effects of landscape heterogeneity on farmland birds

Lunja Marlie Ernst[1], Ine Dorresteijn[1], Jan Hanspach[1], Jörn Fischer[1]

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Agricultural intensification and land use change have measurable effects on farmland bird communities. They are comparable to deforestation and climate change as major human threats to biodiversity. The declining populations of farmland birds in Europe, especially in Western Europe, may be partly the result of the intensification of farmland management in the last few decades.

In this case study the differences of farmland bird populations in more intensive arable landscapes of Western Europe and more extensive agricultural landscapes of Eastern Europe were compared in a literature review. In addition a field study of farmland birds was conducted in Transylvania (Romania), a region still dominated by subsistence agriculture. Sixty sites of 1 ha were surveyed, covering gradients in land cover heterogeneity and woody vegetation cover.

Both the literature review and the empirical study suggested that diversity of farmland birds is strongly related to heterogeneity and woody vegetation cover. The biodiversity of farmland bird populations in Eastern Europe is still higher than in Western Europe, which has experienced decades of European Union agricultural policy geared at increasing agricultural productivity thereby supporting land use intensification.

To reach its goal of halting biodiversity loss by 2020, the European Union must urgently find ways to maintain farmland heterogeneity, especially in the new member countries. This will be challenging: In many instances, the maintenance of heterogeneity is closed linked with traditional farming practices, but those are increasingly less viable economically.

P3 – Graph-theoretic approaches for the forest network management at multi-resolution in Japan

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Reconciling biodiversity and human activity in anthropogenic landscapes is a great challenge of this century. During recent decades, habitat fragmentation is one of the most serious impacts for biodiversity in the landscapes. Because the effective isolation distance that makes fragmentation matters varies among species, it is difficult to make management plans to maintain connectivity by

single-species approach. Therefore, it seems practical to evaluate the candidate set of the species which would be the most seriously affected by habitat fragmentation from the landscape structure itself, because the degree of landscape connectivity can be determined by spatial configuration of habitat patches alone.
Although the degree of landscape connectivity varies with landscape units (or sizes) and proportion of each land cover types in the landscape, previous studies have been carried out only in the single units selected by the researcher.In order to provide effective land-management plan, it is necessary to clarify suitable landscape unit for assessing landscape connectivity.
Considering habitat qualities (types) in the evaluation of landscape connectivity is another important issue. Because origin and disappearance factors differ among habitat types, each habitat type may have different roles in habitat network. However, most previous studies have not considered the difference in habitat qualities to understand forest network.
Using GRAPH THEORY, in this study, we clarified 1) the suitable landscape unit to assess landscape connectivity, 2) How the suitable landscape unit varies with the proportion of forest area within the landscape?, and 3) how each forest type (riparian and non-riparian forest) contribute to forest connectivity.

P4 – Investigating the relationships between the distribution of ground beetles and landscapes history in northern Japan

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Agricultural lands have been expanding rapidly during the last century, resulting in a decrease of natural vegetation. It is one of the main drivers affecting species diversity loss in Japan. In order to alleviate these species loss, firstly we need to understand present distribution of target species and predict future distribution of the species. However the past landscape factors also have significant impacts on the species distribution. For example, if a large forest patch is shrinking rapidly, some species may decrease slowly and thereby survive there even if the forest is small at present. In order to conserve species diversity in agricultural landscape, we need to consider the relationship between not only current but past landscape factors and the present species distribution. In this study we aim to evaluate impacts of landscapes history on distributions of ground beetles (Coleoptera - Carabidae) because of their specific richness, and their sensitivity to the landscapes change.
We surveyed ground beetles in remnant broad-leaved forests in plain fields of Tokachi, Hokkaido (northern Japan). In this region, agricultural land-use dominates, and pre-existing vegetation was Japanese emperor oak (*Quercus dentate*) that have degraded rapidly during the last century. We collected ground beetles with pitfall traps in 39 broad-leaved forest patches, and grouped them by the mean body size of each species. We analyzed landscape cover (area of broad-leaved and conifer forests in the buffer from the center of the sites) in each period (1920s, 1950s, and 2000s) using GIS maps.
In total, we collected 41 ground beetle species in the sites. Our results showed that the group richness of larger ground beetle was positively correlated with the broad-leaved forest area in 1950s and the group richness of smaller ground beetle was negatively correlated with the broad-leaved forest area in 2000s. Our results suggest that past landscapes factors may influence current distribution of some

ground beetles and therefore past landscape factors should be examined in order to understand present distribution of ground beetles and predict future distribution of these species in agricultural lands.

P5 – Pond connectivity and aquatic biodiversity in an agricultural landscape, northern Japan: a habit-trait based approach

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Habitat fragmentation is one of the serious causes for biodiversity decline in agricultural landscapes. Fragmentation-sensitivity of species is closely linked to life-history traits.Thus knowledge about the sensitivity of each life-history group to habitat connectivity is fundamental for practical conservation such as appropriate goal-settings and assessments. However, this knowledge on habitat connectivity in freshwater ecosystems is seriously lacking.
In our study, we focused on a habit classification of aquatic organisms according to their locomotion or behavior in relation to their habitat. Our objective was to clarify the differences of fragmentation-sensitivity among each habit group in a pond network in an agricultural landscape. We surveyed the species richness of aquatic organisms (fish and macroinvertabrate) in 24 ponds during summer season, 2011. The collected fish were classified into 2 groups (Benthic, Pelagic) and macroinvertebrate were classified into 4 groups (Climb, Sprawl, Swim, Skate) based on their habits. Lastly, we examined the relationship between pond connectivity and species richness across the above habit groups using a graph theoretical approach. In this presentation, based on these analyses, we are looking forward to discuss about the necessity of pond network conservation for aquatic biodiversity in agricultural landscapes.

P6 – Relationships between aquatic macrophytes of NW German running waters and habitat characteristics

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The presence or absence of macrophyte species in running waters, which represent different functional types, depends on biotic and abiotic factors. We studied the macrophyte vegetation of 68 streams and rivers of the northwest German plains by means of 291 vegetation plots of 100 m² and determined environmental conditions (e.g. river bed morphology, naturalness, water turbidity, current velocity, pH, Ca and Na in water and sediment, Ctot and Corg in sediment) and concentrations of nutrients and trace elements (e.g. NO_3 and NH_4 in water, N_{tot} in sediment, Al, Cu, Fe, K, Mg, Mn, PO_4, and Zn in water and sediment). We found significant differences of environmental conditions between vegetation alliances and single species. While vegetation assigned to the alliances of Lemnion, Nymphaeion and Potamion was characterized by high ammonium and phosphate concentrations (in the water) and by high concentrations of nitrogen, phosphor, carbon and calcium (in the sediment), alliances of Ranunculion and Sparganio-Glycerion showed affinities to low concentrations of calcium and nutrients in the water and in the sediment. Six species (e.g. *Callitriche hamulata*, *Glyceria fluitans*, *Myriophyllum alterniflorum*) appeared in shallow water courses with natural structure and high current velocity, lower pH, calcium and sodium contents of the sediment and lower magnesium and potassium contents of water and sediment, compared to sites where the species were absent. In contrast, ten macrophyte species (e.g. *Myriophyllum spicatum*, *Potamogeton crispus*, *Spirodela polyrhiza*) occurred in large and deep water courses with low current velocity but high nutrient richness. Finally, species as *Elodea nuttallii* and *Lemna gibba* were also related to high water turbidity, compared to sites where the species were absent.

Session 32 – Species interactions in terrestrial ecosystems

Chair: Martin Entling, Ingolf Steffan-Dewenter

O1 – Latitudinal shifts in species-interactions reduce the resilience of southern bog-ecosystems to climate change

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The persistence of species in a changed climate depends on their adaptive potential. Especially the often small and genetically depauperated populations at the species' range margins can be crucial in containing a gene pool with adaptations to unfavourable climatic conditions.
Many plant species of northern European bog-ecosystems reach their southern range limit in Central-Europe. We performed a common-garden experiment with five species sampled along a latitudinal gradient from Northern Sweden to Germany. Populations were cultivated in monocultures and mixtures and exposed to different climate treatments. Although the common garden was located at the southern edge of the gradient, productivity of the mixtures decreased from northern to southern origins, while southern monocultures showed the highest productivity. Warming and fertilisation distinctively increased biomass in monocultures, but only slightly in mixtures. Diverse communities from the northern core area did not suffer from droughts in contrast to communities consisting of the small and isolated southern edge-populations. Hence, biodiversity seems to buffer against effects of global change. Additive partitioning of biodiversity effects revealed that northern populations benefitted most from growing in communities whereas negative dominance effects prevailed in communities of southern origin under experimental conditions.

O2 – Changes in leaf chemistry by stem galls alter herbivory and decomposition in clonal poplars

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Gall-inducing insects are highly specialized plant feeders, which are able to modify their host plants phenotype. Beyond direct manipulation of plant morphology and physiology in the immediate environment of the gall, there is also evidence for plant mediated effects of galling on associated communities and ecosystem processes. In this study we analysed the effects of galling by the aphid *Pemphigus spirothecae* on chemical leaf traits of clonal Lombardy poplars (*Populus nigra* var. italica) and their effects on herbivory intensity and decomposition of leaves across five sites. Herbivory intensity on leafs was examined distinguishing between two types of feeding guilds: leaf chewing insects feeding on the leaf lamina (such as caterpillars or sawfly larvae) and skeletonising insects feeding on the leaf's mesophyll (e.g. beetle larvae). Our study revealed that galled leaves on average showed a higher phenol and lower nitrogen and cholorophyll content than ungalled leaves. These effects increased over time from June to August in galled leaves and remained on a constant level in ungalled leaves. While total herbivory intensity did not differ between galled and ungalled leaves, leaf chewer damage was on average higher on galled leaves whereas damage of skeletonising insects was on average higher on ungalled leaves. The lower nitrogen content of galled leaf litter compared to ungalled leaf litter slowed down decomposition of ungalled leaf litter. All gall-mediated effects were on average similar across the studied sites.

Overall we showed that presence or absence of galling influences host chemical traits and in turn associated communities and ecosystem processes. As the stem gall *P. spirothecae* acts as physiological sink we suppose that changes in herbivory patterns and decomposition rates are mainly linked to lowered nitrogen level in galled leaves.

O3 – Which plant traits affect herbivory on tree recruits in species-rich subtropical forests?

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Interspecific differences in susceptibility to herbivory can affect plant community structure and might be key to maintaining the extraordinary tree diversity of subtropical and tropical forests. However, we lack a clear understanding of the relative importance of, and the interplay between, the different plant traits that determine herbivore damage. We used a pluralistic approach, incorporating a large number of morphological, chemical, phylogenetic and rarely applied biogeographical characteristics, to analyze differences in herbivory of saplings of 21 tree and shrub species in highly diverse subtropical forests in China. We hypothesized that while traditionally considered palatability and defense traits have strong effects on herbivory, geographic range characteristics not only mediate, but in part complement these effects through evolutionary impacts on herbivore assemblages. Contrary to expectations, we did not find significant effects of chemical defense on herbivory levels. Rather, herbivory was significantly positively related to the species' leaf dry matter content, local abundance, climatic niche width and marginality of climatic conditions at the study site. These predictors were largely complementary, together explaining 70% of the variation in herbivory between species in a phylogenetic regression. Our study shows that besides leaf defense traits and apparency to herbivores, previously neglected measures of large-scale geographic host distribution are important factors influencing local herbivory patterns among plant species.

O4 – Seed predation of common grassland species along an experimental plant diversity gradient

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Biodiversity is essential for ecosystems that are influenced by environmental changes. With high species richness, ecosystem functions cannot only be stabilized but also optimized. Post-dispersal predation is an important ecosystem function, which has a major influence on the seed's fate after the initial dispersal from the mother plant. It can transform plant populations and communities and therefore entire ecosystems. However, little is known about the role of plant diversity on post-dispersal seed predation and on the plant-animal interactions seed predation entails.

The aim of this study was to test whether a change in plant diversity influences the rate of seed predation and whether a switch between different predator groups takes place under different plant diversity.

We conducted this research along an experimental plant diversity gradient, comprising plots from 1 to 60 species mixtures of common grassland species in Jena, Germany. Seed cafeterias were set up as a combination of exclusion experiments with coloured seeds, targeting arthropods and slugs as seed predators. Traditionally, seeds that are missing from seed cafeterias are classified as predated but this new set-up allowed us to obtain more accurate numbers of predated seed by subtracting secondarily dispersed seeds.

Results show that seed species identity as well as seed predator groups are essential for the rate of predation. In general, seeds containing starch were predated more frequently than seeds that were not attractive to invertebrates, regardless of plant species diversity. Mixed modelling revealed that seed predation rates by both slugs and arthropods were largely predicted by vegetation height, with increasing predation occurring in plots with higher vegetation. However, at least for slugs, predation rates were significantly higher in plots with high plant diversity compared to plots with 1 to 8 species mixtures.

These results indicate that plant species richness does not have direct effects on seed predation rates, regardless of seed species or predator group. However, increasing vegetation height, which is indirectly associated with plant species richness, has a positive effect on seed predation.

O5 – Non-consumptive effects are relatively rare among spiders and insects

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Predators affect prey population through direct consumption. In addition, predators can affect prey population through non-consumptive effects (e.g. elicit antipredator behaviour). But yet antipredator behaviour has only been documented for a limited number of terrestrial arthropods. To test for differences in antipredator behaviour among herbivore and carnivore prey, we conducted series of behavioural experiments. We confronted insect and spider species from a wide taxonomic range with chemotactile cues (kairomones) of three spider species that induced antipredator behaviour in preliminary experiments. We applied two experimental setups: in the “no choice experiment” prey individuals were either put on filter papers with or without spider cues. In the “choice experiment” prey individuals were able to choose between filter paper halves with and without spider cues. Based on the behavioural parameters derived from video analysis we calculated the activity of individuals in presence/absence of spider cues. Only two prey species showed consistent behavioural changes throughout both experiments: the wood cricket *Nemobius sylvestris* became more active in the presence of spider cues. This reaction can be interpreted as escape behaviour. Astonishingly, ants of the species *Lasius niger* sped up in the presence of cues of the wolf spider *Aulonia albimana*, suggesting a species-specific relationship. This study represents the first investigation about occurrence of non-consumptive effects across broader ranges of prey taxa. Our results suggest that non-consumptive effects are relatively rare among the investigated species. Due to the bias towards cricket prey in former literature we conclude that strong antipredator behaviour may be an exception rather than the rule among terrestrial arthropods.

O6 – Ecological processes and biodiversity of solitary hymenoptera are more affected by landscape than local land use factors

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Most ecological processes proceed on large than on local spatial scales but still land use-studies fail to include landscape structure or regional variation in analyses of biodiversity patterns. We aim to disentangle effects of local and landscape factors and regional differences on the diversity of trap-nesting bees, wasps and their natural enemies, in combination with parasitism and mortality rates. Species were collected with 760 trap nests exposed from April to September 2008 on 95 grassland plotsin three distinct research regions across Germany. We mapped the proportion of habitats in landscapes surrounding plots within radii of 250 to 2000 m andcalculated landscape complexity, i.e. habitat diversity and shape indices as well as the area of semi-natural habitat. As local factors of potential influence on species diversity and ecological rates, we assessed land use intensity and the

diversity of flowering plants on plots. We found a total of 4604 nests, consisting of 23,922 brood cells, resulting in 48 host species and 27 species of natural enemies. Generally, species richness of hosts and enemies as well as parasitism rates increased with increasing landscape complexity, while mortality rates decreased. Moreover, species richness and rates of biotic interactions increased significantly from north to south Germany. In contrast, local factors were generally not included in minimum-adequate models or non-significant. Best models explaining species richness patterns included landscape factors on the smallest spatial scale (250 m), while parasitism and mortality rates were mainly affected by landscape factors on larger scales. Our study emphasizes that factors operating on large spatial scales are more important than local factors in shaping biodiversity patterns and ecosystem processes. We conclude that conservation of pollinator and predator diversity requires a landscape perspective.

P1 – Effects of endophytic fungi in *Lolium perenne* on alkaloid concentration and trophic interactions between aphids and their predators

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Endophytic fungi of the genus *Neotyphodium* or *Epichloe* occur in most cool season grass species. The hyphae of *Neotyphodium lolii* is growing in the intercellular space of the grass *Lolium perenne* and releases alkaloids into the plant. Aphids sucking on the phloem of infected plants experience strong fitness disadvantages. However it is unknown if the alkaloids enter the phloem and if alkaloids can be detected in the aphids and in higher trophic levels. We investigated whether the two-spotted ladybird *Adalia bipunctata* and the Asiatic ladybird *Harmonia axyridis* are negatively influenced by the presence of alkaloids in their food chain. We could not detect significant differences in the development and the survival rate of the ladybirds. Samples of infected grass, aphids and different aphid predators were examined for their content of alkaloids produced by the endophytic fungi. We detected for the first time the presence of two main alkaloids Peramine and Lolitrem B with High Performance Liquid Chromatographic analysis in every trophic level.

P2 – Drivers of regional- and local scale distribution of insect root herbivores in grasslands

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Insect root herbivores can affect the structure of plant communities. However, what determines their own spatial distribution is not yet fully understood. We conducted two field surveys in three regions in Germany (Hainich, Schwäbische Alb, Schorfheide) forming the network of the 'Biodiversity Exploratories' to determine environmental factors that drive insect root herbivore distribution in semi natural grasslands on the regional and local scale.
On the regional scale insect root herbivore abundance was affected by soil type, and this was most likely one reason for the difference in their abundance between the three regions investigated. Additionally, root herbivore abundance increased with increasing proportion of bare soil, pointing to a preference of

plots with warmer soil temperatures. Root herbivore abundance was not correlated with plant cover or diversity. However, root herbivores were more abundant on fertilized than on control subplots, possibly due to a higher root nutrient content.
On the local scale, investigated on 9 m transects, the impact of the proportion of bare soil on insect root herbivore distribution was not confirmed. Contrarily to their regional scale distribution, their abundance increased with plant diversity on the local scale. Additionally, it was related to the functional composition of plant communities, expressed by community mean traits. Root herbivores had an affinity to traits related to high growth rates and biomass (specific leaf area, reproductive plant height), but their abundance was negatively influenced by leaf tissue density and C/N ratio. Provided that tissue density is a systemic plant trait, this may point towards a preference of less dense root material. Evidence for an impact of the root C/N ratio was not found on the local scale.
Our results so far suggest that plant community characteristics including diversity are more important for insect root herbivore distribution on the local than on the regional scale.

P3 – Trophic diversity in a Mediterranean food web - stable isotope analysis of an ant community of an organic citrus grove

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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 thoroughly a highly diverse Mediterranean ant community in an organic citrus grove in Tarragona, NE Spain, and analysed stable isotope contents of 17 species of ants together with dominating plants and importantspider and aphid species to establish trophic guilds and detect seasonal changes. The results revealed significant differences between species spanning over a huge range in $\delta^{15}N$ values of *ca*. 11‰ which is only comparable to a Peruvian tropical forest with a much higher species diversity. The trophic levelsof ants reflected most of previous knowledge on predaceous vs. plant feeding habits of the species. *Messor* harvester ants and *Camponotus* species had the lowest $\delta^{15}N$ values. Aphids, smaller spider species, and most other ant genera, including the dominating species *Formica rufibarbis* and *Lasius grandis*, had intermediate $\delta^{15}N$ levels. The large spider *Dysdera crocata* and the typical Mediterranean ant *Pheidole pallidula* had higher $\delta^{15}N$ values, but two specialized predatory ants with very tiny workers had the highest trophic level.We found unexpected high $\delta^{13}C$ valueswith a high seasonality for several ground living ant species. The possible role of soil fauna as a second main food resource beside the yet mainly 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 community.

P4 – Land-use intensification decreases phylodiversity of plant communities in local grasslands

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Biodiversity and ecosystem functioning are threatened by several human-caused pressures as climate change, introduction of invasive species and most importantly land-use change and intensification. Land-use intensification not only affects species richness but also alters the phylogenetic and functional composition of communities. Hence a detailed understanding of the relationships between phylodiversity, functional diversity and land-use intensification is important to forecast the consequences of changes in biodiversity. While estimates of functional diversity by means of trait-based approaches suffer from several limitations, phylogenetic diversity can be a useful tool to overcome these shortcomings. Here we analyze the relationship between phylogenetic diversity of plant communities and land-use in local grasslands (150 sites) across an intensification gradient in three regions in Germany (Biodiversity Exploratories: Schorfheide-Chorin, Hainich-Dün, Schwäbische Alb). Applying several indices of phylodiversity dealing with presence/absence and abundance data we found in all three exploratories a decrease in phylodiversity with increasing land-use intensification. Phylogenetic clustering of communities increased with increasing land-use intensification. Overall we show that land-use alters the phylogenetic community composition of plants in grasslands. We suggest that altered phylodiversity of plant communities also has important consequences on trophic interactions and several ecosystem functions.

Session 33 – Structure, function and adaptive plasticity: Roots and rhizosphere under abiotic stress and competition

Chair: Boris Rewald, Douglas L. Godbold, Hans Göransson

O1 - Tree species diversity interacts with elevated CO_2 to induce a greater root system response

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As a consequence of land use change and the burning of fossil fuels, atmospheric concentrations of CO_2 are increasing and altering the dynamics of the carbon cycle in forest ecosystems.In a number of studies using single tree species, fine root biomass has been shown to be strongly increased by elevated CO_2. However, natural forests are often intimate mixtures of a number of co-occurring species. To investigate the interaction between tree mixture and elevated CO_2, *Alnus glutinosa*, *Betula pendula* and *Fagus sylvatica* were planted in areas of single species and a three species mixture in a free-air CO_2 enrichment study (BangorFACE). The trees were exposed to ambient or elevated CO_2 (580 µmol mol^{-1}) for four years, and fine root biomass and turnover as well as fine root characteristics were measured. There were strong differences between the species in the fine root response to elevated CO_2 in terms of biomass and growth. When species were grown in polyculture a greater response to elevated CO_2 was observed at all depths throughout the soil profile, indicating that species grown in mixtures were able to better exploit soil resources.

O2 – Morphological plasticity of EcM roots across climate gradient and successional stage of forests

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Understanding of tree root plasticity is critical in the light of globally changing environments. Functionally important and commonly measured morphological traits of ectomycorrhizal (EcM) roots in forest trees are specific root area, specific root length and root tissue density as well as mean diameter, length and mass or root tip abundance and the degree and type of mycorrhizal colonization. The variation of these traits reflects the range of morphological plasticity of roots depending on species-specific genetic variability as well as differences in abiotic and biotic environmental conditions.By altering these morphological traits, trees can acclimate/adapt their nutrient and water exploitation to the spatially and temporally varying distribution of resources in the soil.
The morphological plasticity of EcM roots was studied 1) across climate gradients (temperature, humidity etc.) from sub-arctic forests to temperate stands in Europe (Norway spruce, Scots pine and silver birch), 2) across successional stage of deciduous forests from primary successional stands in

previous mining areas to natural sites in long-term forest areas (silver birch, grey and black alder) and 3) in polluted soils (hybrid aspen clones). Biotic and abiotic environmental as well as genetic factors affected significantly EcM morphology of trees – the studied stands formed separate groups according to e.g. forest climate zone or successional stage of the site (RDA analysis). EcM roots of hybrid aspen showed different plasticity range in response to soil pollution depending on the clone. Redundancy analysis revealed that biotic (EcM symbionts; root-rhizosphere microbes), abiotic (climate and soil conditions) as well as genetic factors (tree species, different clones) accounted for up to 65 % ($p < 0.001$) of the total variation in EcM root morphology. Variation decreased in the following order: EcM symbiont > climate, soil parameters and successional stage of the sites > tree species/clones.

O3 – Tri-trophic underground symbiosis between a weevil, bacteria and a roots

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Hot and dry environments coerce challenging conditions on its habitants. Water and nitrogen are among the most limiting factors within these environments.The present study describes a unique symbiotic adaptation carried out by a tri-trophic symbiosis among plants, beetles and bacteria. (i) *Salsola inermis* - a desert annual, (ii) *Conorhynchus pistor* - a weevil which live in “mud huts” built on the plant roots and (iii) nitrogen fixing bacteria (*Klebsiella pneumonia*) colonizing the weevils’ guts. We found elevated nitrogen and decreased carbon concentrations in roots of the hosting plants, suggesting that the weevil contributes nitrogen to the plant whereas the plant contributes carbon to the weevil. This reciprocal interaction is possible due to active nitrogen fixing bacteria harboring within the weevil’s gut. The weevils spend most of their life time underground in a mud-hut attached to the root, which affords the beetles an ameliorated microclimate and predator refuge for summer aestivation and winter diapause. Exploring this unique mutualism emphasizes the importance of underground life in the desert and sheds light on a unique phenomenon in which roots serve as a microhabitat.

O4 – Plant-microbial interactions controlling nitrogen partitioning in beech forests

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In nitrogen limited forest ecosystems, plants compete with microbial activities for inorganic and organic nitrogen sources. Especially nitrification and denitrification constitute strongly competitive microbial processes, because they are the energy sources of microbes and, thus, consume nitrogen substrates at high rates. The reactive oxygen species NO is produced as a side product, resulting in NO concentrations of several hundred ppb in the gas phase of the pedosphere. Furthermore, NO has been identified as an important signalling compound in plants and is subject to metabolic control by biosynthesis and degradation processes. Our experiment was conducted in an aeroponic fumigation system using different levels of NO and CO_2. ^{15}N feeding experiments were performed at low and high nutrient

availability. Our study provides evidence that rhizospheric NO can stimulate the uptake capacity of beech roots for reduced nitrogen compounds. Thus, rhizospheric NO mediates microbes-to-roots signaling and determines the competitive strength of beech roots in N acquisition. This NO sensitivity of roots depends on N nutrition. In addition, the microbial NO signal is modulated by the rhizospheric CO_2 concentration.

O5 – Influence of paclobutrazol on tomato root architecture

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Water scarcity is limiting plant growth and productivity in many regions of the world, including agriculturally managed ecosystems. Improving plant tolerance to drought stress becomes increasingly important to maintain high plant productivity in water-limiting environments. For example, the use of plant growth regulators (PGRs) is an important agricultural tool for increasing plant productivity and growth under water deficit conditions. PGRs increase the drought tolerance of plants through both morphological and physiological changes above and below ground. Paclobutrazol (PBZ), for example, inhibits the synthesis of gibberellins while promoting abscisic acid, auxin and cytokinin. However, information about the morphological changes among root systems induced by PBZ and other PGRs is still scarce although root morphology holds important information about root systems' capacity for water and nutrient uptake.
Considering the importance of root systems for drought tolerance, we examined the fine root architecture, morphology and biomass of two *Lycopersicon esculentum* (tomato) cultivars, Ikram (drought tolerant) and Mose (drought sensitive). Root architecture and morphology were analyzed through root orders which represent the root branching hierarchy. Two days after seeding, three different rates of PBZ were applied. Two soil moisture treatments [well watered and water deficit (i.e. 60% of well watered)] were initiated six weeks after seeding and were kept for five weeks. Plants were sampled before the start of the soil moisture treatments and at its fnish.
PBZ enhanced the specific root area, especially of first order roots (i.e. root tips). The diameter of tap roots was larger, and PBZ treated tomato root system had finer side branches. Changes in the numbers of root orders and their frequency, morphology and anatomy indicate major modification of tomatoroot systems under PBZ treatment. As most of the roots were concentrated in the wet zone under drip irrigation, higher specific root areas would improve the efficiency of water and nutrient uptake. The increased root/shoot ratios and decreased leaf areas are additional indicators for the improved drought tolerance of these two tomato cultivars after PBZ treatment.

O6 – Quantitative analysis of the root distribution in a pea and oat intercropping by Fourier transform infrared (FTIR) spectroscopy

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Different rooting pattern and exploration of different soil depths could lead to higher resource efficiency between intercropped legumes and cereals. To analyze below-ground processes, roots of legumes and cereals have to be distinguished from one another. In a recent study, Fourier transform infrared (FTIR) spectroscopy was successfully applied in root discrimination of pea and oat. In this experiment, we expanded this method and calibrated a model based on artificial samples with specific species composition. Species proportions in root mixtures of intercropped plots were quantified by this model.
A replicated field experiment with pea and oat in sole and intercropped plots was carried out in 2011. Roots from the sole plots were used to prepare artificial samples of pea and oat root mixtures to calibrate and validate the FTIR model.
The cross validated model showed a low standard root mean square error of cross validation (RMSECV=3.6) and a high coefficient of determination (r^2=98.5). This model was used to predict species composition in root samples (0-60 cm soil depth) of intercropped plots. The quantification of the intercropped samples revealed that pea roots dominated the samples taken between pea and oat rows. In samples collected on a pea or oat row, even a remarkable amount (up to 10 %) of roots of the neighboring species was found.
The prediction of species composition in mixed root samples by FTIR spectroscopy could be a promising tool for analyzing root interactions in intercrops.

P1 – Reaktion von Ektomykorrhizapilzgemeinschaften auf die Einmischung von Einzelbäumen in Reinbeständen

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Innerhalb des komplexen Verjüngungsgeschehens von in Kiefernreinbeständen einzelbaumweise eingemischten Alteichen wird der Ektotrophen Mykorrhizierung (ECM) der Naturverjüngung einige Bedeutung beigemessen – ist sie es doch, die eine wesentliche Voraussetzung für die Vitalität der Eichensämlinge und -keimlinge schafft. ECM ist verantwortlich für Mobilisierung und Transport von Wasser und Mineralien aus der organischen Bodensubstanz, was in der ersten Etablierungsphase entscheidend die Vitalität der Wirtspflanze bestimmt. Dabei verbinden die Myzelien durchaus artübergreifend alte und junge Bäume miteinander.
Während der Austausch zwischen den Wirten in Altbeständen vergleichsweise gut belegt ist, richtet sich das Augenmerk in diesem Projekt auf die räumliche ECM-Verteilung in Kiefernreinbeständen bei einzelbaumweise verbliebenen Alteichen. Die sich dabei explizit ergebende Stammabstandsabhängigkeit zu den Mutterbäumen wird für die ECM naturverjüngter und künstlich verjüngter Eichen detailliert betrachtet. Es werden in-situ die Mykorrhizierungsrate, das Arteninventar sowie die Explorationstypen der Jungeichenmykorrhizen ebenso untersucht, wie Hyphenverbindungen zwischen Altbaum und Verjüngung.

Die bodenchemische Bedeutung von Streu und organischer Bodensubstanz variiert im Wesentlichen abstandsabhängig und ist von Tragweite für die ECM und somit für den Verjüngungserfolg. Daher werden speziell die Humusbetrachtungen durch Experimente im Gewächshaus untermauert, bei denen das Wachstum einzelner Pflanzensortimente unter manipulierten Bedingungen nachgestellt und mit dem Freiland verglichen wird.

P2 – Plasticity of *Pinus sylvestris* root architecture and EcM colonisation in response to constant vs. seasonal drought

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Many studies have investigated how pines reduce aboveground water loss and increase water use efficiency of physiological processes in response to drought. Little is known however, on how pines adjust biomass partitioning between aboveground and belowground tissues under dry compared to wet conditions. Phenotypic plasticity of the root system may be especially important during the seedling stage, where even short-term drought events may reduce survival drastically. Moreover, pines obligately depend on the symbioses with ectomycorrhizal (EcM) fungi for successful seedling establishment and EcM species and drought can affect EcM colonisation and species composition, which may, in turn, affect the drought resistance of their hosts.
We compared allocation of *Pinus sylvestris* seedlings to aboveground and belowground biomass, root length and EcM colonisation in the organic vs. mineral soil layer under three different precipitation regimes simulated in a common garden experiment with mobile rainshelters.
P. sylvestris seedlings grown under both constant and seasonal drought had three times lower aboveground biomass than seedlings grown under wet conditions. Although root biomass also decreased under drought, seedlings invested disproportionately more biomass into the root system resulting in a higher root-shoot ratio. In both drought treatments, seedlings reduced root length in the organic soil layer by more than half compared to the wet treatment, but root length was constant across all treatments in the mineral soil layer. EcM colonisation was higher in the organic than the mineral soil layer but did not differ between precipitation regimes. The number of EcM species that colonised roots in different treatments and soil layers was proportional to root length. Under both constant and seasonal drought, seedlings increased resource uptake capacity by increasing the number of root tips per root length in both soil layers. By contrast, seedlings did not increase their cooperation with EcM fungi as indicated by constant mycorrhizal root tip density across treatments. Our results show that biomass allocation in response to drought is highly plastic in *P. sylvestris* seedlings, which may be beneficial for adaptation to increased frequency and duration of summer drought, as predicted for Europe under climate change.

P3 – Interactions between root associated fungi and bacterial grazers affect plant nutrient uptake and growth

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Nitrogen (N) frequently limits plant growth in terrestrial ecosystems. To meet the demand for N, roots of most plants interact with microorganisms of different phylogenetic affiliation and trophic level. According to the 'microbial loop' in soil, protozoa foster plant nutrient uptake by re-mobilizing nutrients from bacterial biomass. This interaction can be mediated by fungal symbionts associated with the plant roots. To address this question we conducted a microcosm experiment to test whether N nutrition and performance of winter wheat (*Triticum aestivum*) is mediated by the interaction between bacterial feeding protozoa (*Acanthamoeba castellanii)* with an endophytic root fungus (*Acremonium strictum*) and a mycorrhizal root fungus (*Glomus intraradices*).
Endophytes attenuated growth promotion of protozoa by reducing plant N uptake. Endophytes, AM fungi, and protozoa combined reduced the development of the root system compared to the stimulating effects of protozoa and endophytes alone. The positive protozoan effect on above ground foliar biomass was reduced in presence of AM fungi.
The results demonstrate that protozoa and soil fungi strongly interact, affecting plant growth responses and microbial interactions in the rhizosphere. Our results suggest that thefunctioning of fungi in plant nutrient acquisition and growth can only be understood by considering multitrophic interactions between fungi and bacterial grazers in the rhizosphere. Uncovering the mechanisms involved in these interactions is key for understanding plant nutrient uptake and plant competition in terrestrial ecosystems.

P4 – Adverse effects of fungicides on ectomycorrhizal mycelium growth - impact of quinoxyfen, boscalid, tebuconazole and azoxystrobin

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Ectomykorrhizal fungi (ECM) are symbionts of tree species such as European beech (*Fagus sylvatica* L.). In Germany about one third of the landscape is forested, the European beech dominating large areas. Mycorrhized plants have an increased and thereby more efficient water and nutrient uptake and are better adapted to the specific challenges of climate change, such as drought stress [1].
Studies have shown that fungicides on the one hand stimulate and on the other hand inhibit mycorrhization [2,3]. However, the impact of fungicides on the mycorrhizal symbiosis is poorly understood. This is especially true for new and modern active compounds.
The impact of authorized fungicides used in agriculture and forestry on the ECM fungi *Pisolithus arhizus*, *Hebeloma crustuliniforme*, *Lyophyllum* sp. and *Cenococcum geophilum* was investigated. In a first step active ingredients quinoxyfen, boscalid, tebuconazole and azoxystrobin were examined in in-vitro experiments under laboratory conditions. In a consecutive step corresponding commercial fungicide formulations were used. For this purpose, serial dilutions were prepared from 0.1% to 200% of the application rate used in agriculture and forestry together with controls at each dilution step.

Tests were conducted in Petri dishes. For the tests mycelium was taken and placed on the treated medium. The test tubes were incubated for 29 days at 25°C in the dark. The evaluation and quantification was performed by determination of the radial growth of mycelium corrected by results from the control group.
In all disk tests tebuconazole caused the strongest inhibition whereas the lowest inhibition of mycelial growth was found for quinoxyfen. For *Pisolithus arhizus* an inhibition was found even at 0.1 % application rate for three fungicides. For *Cenococcum geophilum* an inhibition was found at 10% application rate using tebuconazole. Interestingly an irreversible damage of ECM was found. Hence, ECM with inhibited growth after 29 days shows adverse effects on mycelial growth even after re-inoculation on untreated culture medium.

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P5 – Influence of N nutrition on the root system development of two short rotation species

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Short rotation forestry allows the fast production of biomass for applications such as wood chips or pulp wood. The competition for land is often forcing the use of marginal agricultural land, like clayey or shallow soils, for short rotation plantations. The suboptimal water supply of these sites, and the high water demand of the fast growing poplar and willow clones, makes short rotation plantations prone to water stress. Because an extensive and healthy root system is, among other factors, an essential drought avoidance strategy of plants, this study addresses the influence of differentiated ammonium and nitrate nutrition on the root system development.
In this study two common short rotation species (*Populus spp.* 'Max 4' and *Salix spp.* 'Inger') were grown from 20 cm long cuttings. The plants were fertigated every other day by five different ammonium:nitrate solutions (50:50; 37.5:62.5; 25:75; 12.5:87.5; 0:100) but with the same total amount of nutrients. Overall plant development, photosynthetic activity and transpiration were measured monthly. After four months, plants were harvested to determine the total biomass production, the root/shoot ratio, and the size and morphology of the root system. Analyses based on root orders were used to classify the root branching hierarchy in detail.
The root system development under different ammonium and nitrate nutrition and the implications of fertilization-induced plant traits able to mitigate drought stress will be discussed.

P6 – Effects of drought stress and elevated atmospheric CO_2-concentrations on Sorghum and Maize root systems

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The climatic change will have an impact on 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 seem 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. Research on the effects of increasing [CO_2] and drought stress on the root system of Sorghum and Maize plants under conditions of Central Europe has not been done by now.
At the Johann-Heinrich-von-Thünen-Institute in Braunschweig, root growth of two Sorghum cultivars, 'Bulldozer' (*Sorghum bicolor*) and 'Inka' (*Sorghum bicolor* x *Sorghum sudanense*) and a Maize cultivar 'Simao' were grown under high [CO_2] and drought conditions simulated in a Free Air Carbon dioxide Enrichment (FACE) field trial (580 ppm CO_2) equipped with rainout-shelters in contrast to current [CO_2] and soil moisture conditions (ambient). At harvest soil samples were taken down to a depth of 110 cm. Characteristics of the root system (root length density (RLD) etc.) were determined by scanning of sampled roots and analyzing with the computer programme WinRhizo.
Significant differences of root development between all cultivars were found in the 0-0.4 m soil layer and for the total root system. Under drought stress, elevated CO_2 resulted in significantly lower RLD of the sorghum cultivar 'Bulldozer' compared to ambient [CO_2], whereas no difference was observed for 'Inka' and an increased RLD for 'Simao'. Under elevated [CO_2], trends of decreasing total root length and increasing specific root length were observed irrespective of cultivar.

P7 – The influence of competition on corn root growth

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Studying root dynamics and belowground plant-plant interactions is essential for understanding the composition of plant communities, the impact of global change, and terrestrial biogeochemistry. While most soil samples and minirhizotron pictures hold roots of more than one plant individual, information about root affiliation to certain plant individuals is decisive to determine competitive interactions.
We grew transgenic *Zea mays* plants, expressing green fluorescent protein (GFP), in isolation and in mixture with non-transformed plants in a greenhouse. Using a special minirhizotron system able to detect GFP fluorescence and a VIS minirhizotron camera, the root systems were taped weekly to determine root growth. Pictures were analyzed, separated by local competitive situation, using WinRhizo Tron.

GFP expressing and non-GFP plants were easily distinguished by the strong, green fluorescence of transgenic roots as compared with minor autofluorescence in non-GPF roots. The differences in root dynamics and longevity under competition and in isolation, and the future use of GFP for studies on root dynamics will be discussed.

The stable expression of GFP in crop plants allows conducting advanced studies on intra- and interspecific competition in monocultures and inter-cropping systems. Future studies should use GFP expressing plants to determine spatial and temporal rooting pattern in agricultural mixtures *in situ*.

Session 34 – Free Session

O1 - How important are biotic interactions for local adaptation? Consequences for response of plants to climate change

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The response of plants to climate change is closely related to their degree of local adaptation to habitat conditions with loosely adapted populations having possibly a larger adaptive potential. Two major classes of ecological filters determine local adaptation in plants: abiotic stress (e.g. water availability) and biotic interactions the latter of which has been widely ignored. Studies of plant-plant interactions along environmental gradients indicate a trade off between competition and facilitation with decreasing water availability, i.e. adaptation to competition may be more important under benign conditions. In addition, plant-soil interactions have not been treated in local adaptation studies, except for negative plan-soil feedbacks. Therefore, we know virtually nothing about the role of biotic interactions as selective force relative to abiotic factors.
Here we combined reciprocal sowing, neighbor removal and soil transplant along a rainfall gradient using populations from Mediterranean and Semi-Arid ecosystems. We tested statistical interactions between planting site, seed and soil origin, and neighbor presence. Our results suggest that indeed, plant-plant and plant-soil interactions play a major role for determining plant performance, with complex interactions with species and climatic region. Therefore, biotic interactions must be addressed when studying local adaptation in the future.

O2 – Effects of expected climate change on the butterfly *Erebia medusa*

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Global warming will likely be accompanied by an intensification of climate extremes, such as more frequent and intense heavy rain spells. How such combined, multiple climatic drivers will affect endangered species with special habitat requirements and a narrow ecological niche is largely unknown. However, such knowledge is crucial for species conservation. In a mesocosm experiment in Bayreuth, Germany, we investigated how winter warming and heavy rain spells affect development and survival of the rare butterfly *Erebia medusa*. *E. medusa* lives in nutrient poor, extensively used or fallow mountain meadows. *Festuca ovina,* one of the main food plants of the caterpillars of *E. medusa*, grows on such meadows. Caterpillars hatch in spring and feed throughout the summer until the beginning of autumn. During winter they survive in litter, pupate in early spring and adults hatch on average from mid of May till mid of June. Eggs were collected in May/early June of 2010 and were placed in mesocosms planted with *Festuca ovina* and associated herbaceous species. Two different treatments, matching climate

projections for Germany plus a control treatment, were applied: i) mesocosms were subjected to heavy irrigation in September/October for 3 weeks ii) mesocosms were warmed during winter using infrared lamps additionally to heavy rain spells, and iii) a control treatment with no climate manipulation was applied.
We found that warming with rain drastically shortened the developmental time of the caterpillars and decreased larval mortality. Adults hatched significantly earlier out of pupae in the warmed mesocosms, however, female weight and oviposition was reduced. Extreme rain without warming surprisingly increased mortality of adults. Our findings imply that heavy rain spells that are projected to become more frequent in Germany under climate change might lead to a reduction of fitness in *E. medusa* populations. As warming advances adult eclosion, this might make adults more susceptible to die from late frosts. Hence current habitats might not be suited to fit the needs of *E. medusa* in the future. Such findings should be taken into account for conservation actions.

O3 – Intraspecific stable isotope investigation of four temperate ant species: life stages, castes and temporal patterns

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This study provides information on the trophic relations of four sympatric ant species, the myrmicine *Myrmica sabuleti* and the formicines *Formica lemani, Lasius flavus* and *L. platythorax*, from an isolated limestone pavement in the West of Ireland derived from natural abundances of ^{13}C and ^{15}N determined using EA-IRMS. Differences in ^{13}C and ^{15}N levels were found between the species at every life stage. The highest ^{15}N levels were found for *L. flavus*, suggesting that its large involvement in the belowground food web, determines the ^{15}N enhancement, rather than its trophic level. Both, $^{12}C/^{13}C$ and $^{14}N/^{15}N$ isotopic ratios of larvae and pupae of the four ant species were different from those of the imagines, supporting the metamorphic shift hypothesis. It was found that a methodical agreement to include the abdomen in determinations for the comparison of life stages would help verifying this result and future comparative studies. The castes of workers and females (alatae) of formicines showed no differences in C:N ratios nor in their isotopic composition of $^{12}C/^{13}C$ and $^{14}N/^{15}N$, suggesting that trophallaxis in ants must be seen strictly feeding all castes equally, and this could also apply for larvae and pupae. Interestingly, ant workers do not show seasonal differences regarding $^{14}N/^{15}N$ but *Lasius flavus* and *Myrmica sabuleti* show a depletion of ^{13}C during the active season.

O4 – Patchiness along a gradient of salinity and herbivory: an experimental approach

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In many systems we find patterns of patches defined by e.g. the presence and absence of vegetation or short and tall canopy height. This patchiness of vegetation structure is an important determinant for floral and faunal biodiversity and hence is relevant for nature conservation.
Several studies with a theoretical approach compare modeled patchiness with observed patterns in nature. It was found, that with increasing environmental stress vegetated patches become smaller, but experimental approaches are scarce. Additionally, only very few of these consider either how **small scale abiotic factors** or **biotic stress** incurred by herbivores can be the driving factors in patch formation.
We installed an experiment along a gradient of abiotic stress (salinity) and biotic stress (livestock density) to investigate their combined effects on patchiness of the vegetation structure, while taking small-scale abiotic variation into account. This information will help to unravel the mechanisms behind patch formation.
The experiment was setup on a salt marsh in The Netherlands in 2010 in two blocks. Each block is subdivided in four paddocks of 11 ha, to which the following treatments were applied: horses (0.5 and 1.0 animal/ha) and cattle (0.5 and 1.0 animal/ha). The paddocks were installed perpendicular to the seawall and thus include high salt marsh close to the seawall and low salt marsh close to the intertidal flats. Six transects of 25 m length were randomly positioned in each paddock with three in the high and three in the low marsh. Along each transect the canopy height was measured every 25cm with a Styrofoam drop disk of 25cm diameter and a calibrated stick. Additionally the elevation above MHT was measured at each point using a leveling instrument to account for small scale abiotic variation.
Each transect was analyzed using geostatistical methods. By fitting a model to the variogram we obtained the parameters characterizing the spatial correlation. These parameters were compared to find out how salinity and herbivore density/livestock type affect patchiness of the vegetation structure. We expect to find a strong influence of small scale abiotics on patch position and alteration of this underlying pattern by grazing.

O5 – Informed constraint: merging single-species predictions with community indices to predict local community composition

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Statistical models of species distributions often do not directly translate into local community composition. Dispersal and ecological interactions may restrict the abundance and presence of species. In this talk, we will explore whether community-level indices (diversity, rank-abundance curve, etc) can be employed to constrain single-species predictions. We evaluate our approach using a large data set of benthic macroinvertebrates from the Dutch Wadden Sea. Several patterns emerged: Firstly, the prominent claim that stacking single species models will yield a biased prediction of community size could not be confirmed. Instead, local species richness could be as well predicted from environmental characteristics by stacking single-species regressions as analysing richness directly. Secondly, we used a Bayesian hierarchical approach to describe the relationship between rank-abundance curves and environmental predictors. Based on these findings, we re-scaled occurrence probabilities of single species to yield abundance estimates. While this approach provided some interesting insights into environmental controls over abundance patterns within communities, it did not yield high-quality abundance estimates for specific species.

O6 – Big tropical floodplains around the world - where do we stand?

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Freshwater wetlands around the world share high ecological and economical importance. However, their ecology and functional diversity is only poorly understood to date, especially in the tropics. Tree ecology in big tropical forested wetlands along major rivers is often almost unexplored. In order to highlight the status quo and the major needs for future research, available data of tree growth, phenology, photosynthetic performance and seedling regeneration is brought together in a comparative review of three major tropical freshwater wetlands on three continents, (i) Central Amazonian floodplains in South America, (ii) the Okavango Delta region in Africa, and (iii) the Mekong floodplains of Asia. They all have a predictable “flood pulse” as major driving force influencing all living organisms in the flood plain, however also as source of stress for which specialized adaptations for survival are required. The little available data show that e.g. morphological adaptations and phenological responses to the flood are similar in the three ecosystems. Many deciduous species and also many ‘evergreens’ respond with leaf shedding. Floodplain trees are found to have active sap flow for most of the year and their growth is not inhibited by the flooding. This growth depends on adequate carbohydrate supplies and physiological adaptations. Seedlings are highly tolerant of waterlogging or even submergence. The dispersal of seeds is often linked to the water regime. For floodplain conservation, more information is needed on regeneration requirements, wood productivity and non-timber products, preferably generated using reproducible comparative methods. In the light of climatic change, with increasing drought or extreme flood events, decreased groundwater availability and changes of flooding periodicities, this knowledge is needed ever more urgently to facilitate fast and appropriate management responses to large-scale environmental change.

P1 – Soil seedbanks – biodiversity refuges or spill-over from the extant vegetation?

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Soil seed banks serve a dual function in terrestrial ecosystems; they represent memories of populations and communities past, but also a potential for their future persistence and survival. It follows that the size and longevity of seed banks affect the resilience of plant populations and communities. This has been found to apply both at ecological timescales, where seed banks can contribute to local population persistence and biodiversity maintenance (e.g. through bet-hedging germination strategies and temporal storage effects) and at evolutionary time-scales where seed banks, through increasing the mean generation times of populations, can affect the potential rate of evolutionary change, for example in the face of future climate change.
The potential importance of seed banks has also been recognized by applied ecologists, who have been particularly interested in their potential contributions to the conservation and restoration of threatened and declining plant populations and communities. However, empirical case studies of such systems typically find seed banks to be floristically depauperate, weedy, and it is generally concluded that seed banks are of relatively little value for conservation and/or restoration management.
We propose that the discrepancy between the results of theoretically-driven and conservation-motivated seed banks studies can, at least partly, be attributed to sampling issues: The area sampled for seed banks is typically ~2 orders of magnitude smaller that the area sampled for the extant vegetation., leading to potentially serious but unknown biases in the relative biodiversity and vegetation-seedbank similarity estimates reported.
In this study, we address these issues by comparing species-area-relationships (SAR) of seed banks vs. extant vegetation of seminatural grasslands based on exhaustive surveys of species occurrences and abundances below and above ground. We found strong SAR in both vegetation and seedbanks, but contrary to the commonly-reported pattern, seedbanks had consistently higher diversity at scales > 64cm^2. A literature study revealed seedbank SAR similar to those reported in the field study across five continents and six biomes, with variation between habitat types (grassland, heathland, forest). The relatively low similarity often found between seedbanks and vegetation mainly reflects spatial scale and differences in life-history strategy.

Our study suggests that the perception that seedbanks are intrinsically less diverse than above-ground vegetation has been based more on inadequate sampling than on biological reality.

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