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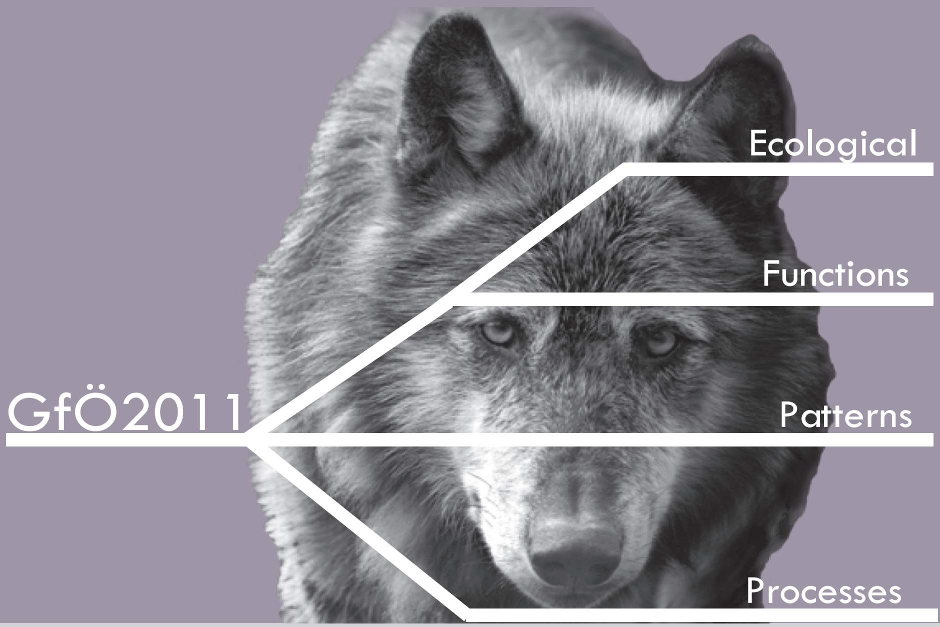

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41st Annual Meeting

"Ecological Functions, Patterns, Processes"

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Book of Abstracts

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The 41st annual conference of the Ecologcal Society of Germany, Austria and Switzerland (GfÖ) is taking place from the 5th to 9th of September 2011 at the Carl von Ossietzky University of Oldenburg. Host of the conference is the Landscape Ecology Group.

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This 'Book of Abstracts' is a compilation of abstracts of almost 300 oral and approximately 130 poster presentations, together with a list of participants and authors. The respective authors are responsible for the contents of this booklet: Editorial deadline: 17th August 2011.

The book is also available for download as electronic document on the conference web site for all registered participants: www.gfoe-2011.de/download/gfoe2011_abstracts.pdf

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Dear friends and colleagues,

I cordially welcome you to the 41^{sr} Annual Meeting of the Ecological Society of Germany, Austria & Switzerland (GfÖ). Being born and raised in northern Germany, it is a great pleasure for me that our this year’s meeting takes place at the wonderful city of Oldenburg. This is almost like welcoming you home. The Carl von Ossietzky University is a very young and dynamic university, dedicated to excellent ‘*interdisciplinary research at the intersection of natural and social sciences*’. I am quite sure that many of our members would also consider this statement to be one of the GfÖ missions. The Oldenburg University is thus an ideal place for us to meet, to discuss exciting ecological topics, to approach new frontiers of our discipline, to exchange ideas, and – last but not least – to socialize.
The year 2011 is – numerically not very surprising – the first year after 2010. However, for us as ecologists this is *year one* after the aim ‘to achieve by 2010 a significant reduction of the current rate of biodiversity loss at the global, regional and national level as a contribution to poverty alleviation and to the benefit of all life on Earth’ has not been reached. Though this may be quite frustrating to many of us, as scientists we have to proceed with our work unwaveringly – to the benefit of biodiversity and human beings. Our resolution ‘The 2013 Target – a New Chance for European Biodiversity’ approved at the meeting in Giessen last year provides a good starting point, since it devised some challenging targets that require scientific support: (i) conservation of biodiversity for whole regions, (ii) establishing a knowledge-based framework for monitoring biodiversity and predicting its changes in Europe, (iii) including the economic consequences of biodiversity loss into management concepts supported be the European Commission, (iv) merging the efforts to halt biodiversity loss with those aiming to reduce climate change, and (v) taking responsibility for global biodiversity. These statements aroused considerable attention among policy makers and stakeholders. It is obvious that the scientific progress that has to be made for achieving these ambitious targets cannot be confined to ecologists specifically devoted to biodiversity research, but must also include scientists covering all other fields of our exciting discipline. This is very nicely expressed by the motto of the Oldenburg meeting: ”**Ecological Functions, Patterns, Processes**”, with which the local organizers explicitly intend to stimulate scientific discussions related to the functional responses of species and communities to environmental changes and associated effects on ecosystem processes as well as to the temporal and spatial dimensions of ecosystem organization that support biodiversity.
With this in mind I am looking forward to a creative, dynamic and communicative meeting in the friendly and stimulating atmosphere of Oldenburg.

Volkmar Wolters

President of the GfÖ

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Keynotes

Keynote 1

The effect of global climatic change on plant and ecosystem functioning

Rien Aerts[1]

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Climate change in cold biomes not only involves higher summer temperatures, but also warmer springs and more winter precipitation. So far, little is known about ecosystem responses to these seasonal components of climate change. Since 2000, we experimentally manipulate spring and summer temperatures and winter snow accumulation and temperatures independently in a peatland in sub-arctic Sweden and studied plant and ecosystem responses.

Surprisingly, species diversity was even after 8 years not affected by the treatments. This was due to the "vertical race for space" between the dominant peat moss (*Sphagnum fuscum*) and the vascular plants as a result of which there was no net effect of the treatments on diversity despite strong summer warming effects on *Sphagnum* growth and the growth of the vascular plants.

Litter decomposition showed after 4 years of incubation strong interspecific differences and there were significant summer and winter treatment effects. However, the treatment effects were relatively small. This was different for soil respiration. Using a new isotopic technique, we were able to show that summer warming increased ecosystem respiration with ±50% and that 70% of this increase originates from sub-surface peat ("old peat"). Given the large carbon stocks in high-latitude peatlands, this implies a positive feedback on global warming.

Summer warming affected both the microbial N immobilization and the flux of organic N, but not N mineralization. For the organic flux there was an interaction with the winter treatments.

From these results we conclude that summer warming affects a wide variety of ecosystem processes in this sub-arctic environment. However, also spring and winter events are important. Thus, the timing of the manipulations matters and should be taken into account in future experiments.

Keynote 2

Plant functional effects on ecosystems

Sandra Lavorel[1]

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Plant diversity has been shown to contribute significantly to the delivery of ecosystem services. Specifically, functional composition, that is the range and relative abundances of trait values present in plant communities, has been shown to strongly determine different ecosystem properties and services. I will first review the evidence for effects of plant traits on ecosystem functioning and present a conceptual framework linking environmental change to changes in ecosystem functioning through plant traits. I will then demonstrate the application of the framework to the quantification of ecosystem services provided by mountain grasslands and illustrate how trait-based understanding can support management for multifunctional landscapes.

Keynote 3

The Dynamics of a Neotropical Forest: Niches, Neutrality, and the Enemy Susceptibility Hypothesis - Perspectives from a 30 Year Study of the Tropical Tree Community on Barro Colorado Island, Panama

Stephen P. Hubbell[1]

[1]Department of Ecology and Evolutionary Biology, University of California, Los Angeles, US
[2]Smithsonian Tropical Research Institute, Panama, PA

Keynote4

Biodiversity and ecosystem resilience and stability

Mathew A. Leibold[1]

[1]Section of Integrative Biology, University of Texas at Austin, Austin, US

The resilience and stability of ecosystems depends on the composition of the resident community in complex ways. Some of the factors likely to contribute to resilience and stability include species richness, the type and amount of environmental forcing on the ecosystem, and the nature of compensatory dynamics among species. I will describe the results of three experiments that examine such effects. They show that diversity can strongly enhance the resilience of an ecosystem to a single perturbation, that recurrent environmental forcing can stabilize ecosystems due to enhanced compensation of population dynamics and that such compensation can depend on the biodiversity and openness of the ecosystem to the ambient metacommunity. The detailed mechanisms involved however are complex, hard to identify and inconsistent from one experiment to another indicating that they may be highly context dependent. Nevertheless, despite these highly context-dependent detailed mechanisms, biodiversity generally seems to lead to enhanced stability and resilience as a possible emergent property of ecosystems.

Keynote 5

Life in a mosaic of stressors: an evolving metacommunity approach

Luc De Meester[1]

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Ecological and evolutionary processes have largely been studied separately, yet there is growing evidence that ecological and evolutionary dynamics can occur at the same time scale and can strongly interact. Ignoring these interactions may distort our view on population, community and ecosystem responses to environmental change, including human impact. The evolving metacommunities framework tries to disentangle the relative importance of species and genotype sorting in determining community trait responses to environmental gradients locally and regionally. A key aspect that determines the outcome of eco-evolutionary interactions is the rate of local species sorting and genetic adaptation versus immigration rates. I will illustrate these concepts amongst others with our own research, using the water flea and its responses to natural and anthropogenic stressors as main model system. I will discuss evolution-mediated priority effects and responses to climate change, and try to sketch an integrated approach that integrates widely different approaches ranging from field based community research to eco- and paleogenomics.

Keynote 6

Linking phylogenetic history, plant traits and community assembly across environmental gradients in time and space

Jeannine Cavender-Bares[1]

[1]Department of Ecology, Evolution and Behaviour, University of Minnesota, US

Deciphering the ecological and evolutionary processes that underlie the assembly of natural communities has never been more important than in our current era of rapid global change. The increasing availability of phylogenetic data and the emergence and expansion of functional trait databases have led to greater availability of information about the evolutionary relationships and functional attributes of organisms than ever before. These trends, in concert with increasing computing power and informatics tools, have facilitated an integration of community ecology and phylogenetic biology. Harnessing phylogenetic and functional information to understand and forecast changes in diversity and dynamics of communities is a critical step in managing and restoring the Earth's biota. I will present a general framework and several case studies, ranging from oak savannas to urban households, to illuminate the importance of phylogenetic information, in combination with plant functional traits, for increasing our understanding of community assembly across environmental gradients in time and space. I highlight areas where future research is greatly needed and emphasize the importance of understanding community assembly processes for maintaining Earth's life support systems.

Keynote 7

Exploring the landscape ecology- spatial planning interface: defining gaps and building bridges

Paul Opdam[1]

[1]Landuse Planning Group, Wageningen University, Wageningen, NL

With its explicit spatial focus, landscape ecology seems to be the ideal science to inform spatial planners about the functioning of the landscape. Yet, the impact of landscape ecology in planning is considered insufficient. In this plenary I will explore causes for this lack of impact, and discuss suggested solutions. Important causes are:

1. *Different paradigms between* landscape ecologists and planning scientist.
2. *Wrongly assuming that the problem is clear,* while in the planning world the problem is still debated
3. *Technical focus*. Many problems in environmental management are primarily caused by societal and economic processes instead of by ecological processes.
4. *No link to value*. Landscape ecology focuses on pattern-process relationships in landscapes, but planning landscapes is about creating added value.
5. *Too much focus on assessment studies*. These are studies where many things are structured, and analytical methods can be applied. Adapting landscapes at the local level is a wicked problem, which requires a design oriented approach.

Improving the effectiveness of landscape ecological knowledge in spatial planning requires a much better understanding of what makes landscape ecology knowledge transferrable and useful, in different phases of planning. This field of research is largely unexplored.

A1 Applications of functional traits to reveal ecosystem responses to environmental change

Oral Presentations

A1-O1: TRY - a global database of plant traits

Jens Kattge[1], Sandra Díaz[2], Sandra Lavorel[3], I. Colin Prentice[4], Paul Lleadley[5], Gerhard Bönisch[1], Christian Wirth[6]

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[2] Forest Ecology and Forest Management Group Universidad Nacional de Córdoba (CONICET), Córdoba, AR
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[5]Université Paris-Sud, Paris, FR
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Plant traits – the morphological, anatomical, physiological, biochemical, and phenological characteristics of plants and their organs – determine how primary producers respond to environmental factors, affect other trophic levels, influence ecosystem processes and services, and provide a link from species richness to ecosystem functional diversity. Trait data thus represent the raw material for a wide range of research from evolutionary biology, community and functional ecology to biogeography. Here we present the global database initiative named TRY, which has united a wide range of the plant trait research community worldwide and gained an unprecedented buy-in of trait data: so far 93 trait databases have been contributed. The data repository currently contains almost three million trait entries for 69,000 out of the world's 300,000 plant species, with a focus on 52 groups of traits characterising the vegetative and regeneration stages of the plant life cycle, including growth, dispersal, establishment and persistence. A first data analysis shows that most plant traits are approximately log-normally distributed, with widely differing ranges of variation across traits. Most trait variation is between species (interspecific), but significant intraspecific variation is also documented, up to 40% of the overall variation. Plant functional types (PFTs), as commonly used in vegetation models, capture a substantial fraction of the observed variation - but for several traits most variation occurs within PFTs, up to 75% of the overall variation. In the context of vegetation models these traits would better be represented by state variables rather than fixed parameter values. The improved availability of plant trait data in the unified global database is expected to support a paradigm shift from species to trait- based ecology, offer new opportunities for synthetic plant trait research and enable a more realistic and empirically grounded representation of terrestrial vegetation in Earth system models.

A1-O2: Plant functional groups in response to grazing - a grassland model

Anne Zemmrich[1], David D. Briske[1]

[1]Department of Ecosystem Science and Management, Texas A&M University, College Station, US

Plant functional classifications categorize plants on the basis of their morphological, physiological, and phenological trait patterns. They attempt to establish functional response groups by aggregating those species with the same behaviour in response to environmental disturbances such as grazing. Plant traits have been variously correlated with grazing along broad environmental gradients during the past 2 decades, but the prediction of species compositional change to livestock grazing in specific communities has received far less attention. We here present a predictive framework of plant response to grazing based on an *a priori* approach to functional group construction that categorizes individual perennial grasses into response groups for management purposes. This framework: 1) is based on homogenous ecological sites to minimize the confounding effects among response traits due to heterogeneous environmental filters, 2) presents functional traits that mediate avoidance and tolerance strategies of grazing resistance based on empirical data and ecological theory, 3) ranks the relative survival and performance of the specific functional response groups along a grazing gradient according to their possession of unique sets of tolerance and avoidance traits. This framework enables us to scale the concept of grazing resistance from traits associated with individual plants to entire communities and may provide a mechanistic link with plant life history strategies and plant performance along gradients of grazing intensities.

Session A1-O3: Trait variance partitioning in two grassland communities

Verena Cordlandwehr[1], Alejandro Ordonez[1]

[1]Community and Conservation Ecology, University of Groningen, Groningen, NL

The structuring of communities have been usually explained by two alternative mechanisms: habitat filters and niche partitioning. These mechanisms, or assembly rules, are often considered as filters, screening species from the available species pool to the actual community. In this study we aimed to determine the importance of habitat filters vs. niche partitioning processes in structuring communities.

For this we examined the patterns of plant functional trait distribution (i.e. canopy height, leaf dry matter content and specific leaf area) in established communities relative to the trait spectrum of the species pool. We focused on two grasslands in a brook valley and in a salt marsh, and used a hierarchical variance partitioning approach across different scales (from the individual-level up to the study site-level) to determine the level of trait variability at each scale.

For both sites traits vary most on the species-level, thus between the species co-occurring on a plot. The comparison of the observed trait variance patterns to three different null models showed that individuals and their trait composition within study sites are not placed totally random across plots. Individuals within species are more similar in their traits within plots than expected by chance, which can be explained by both phenotypic and/or genetic adaption to the habitat characteristics of plots. In the salt marsh trait variance on the species-level tend to be lower and trait variance on the plot-level tend to be higher than expected by chance indicating a strong habitat filter. In contrast in the brook valley leaf trait values are somewhat overdispersed on the species-level indicating that niche partitioning slightly prevails over habitat filtering.

A1-O4: Environmental constraints on the stoichiometry of plant organs in salt marshes

Vanessa Minden[1], Michael Kleyer[1]

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The tissue-differentiation of higher plants into roots, stems, leaves and, later in ontogenesis diaspores has lead to a specialization of function, which is e.g. provision of water and nutrients by roots, or synthesis of photosynthates by leaves. As a result, C:N:P ratios differ between organs in multicellular organisms. However, the elemental composition of tissue also depends on the availability of nutrients and water by the environment.

We investigated the influence of the environment on the stoichiometry of salt marsh plants in Northwest Germany and distinguished between four different habitats, which differed in regard to inundation frequency, level and salinity of groundwater and nutrient availability.

Bivariate-line revealed that species of the frequently inundated lower marsh showed lower C:N ratios than those of the infrequently inundated upper marsh, as an adaptation to salt stress. The influence of nutrient availability was detectable in increased C:P and N:P ratios in nutrient poor sites, indicating a stoichiometric response to P-availability. Across habitat types, leaves and diaspores showed higher elemental homeostasis than stems and below-ground organs.

There were distinct patterns of C:N:P ratios of plant organs in relation to their function and to environmental constraints. A higher degree of homeostasis could be detected in leaves and diaspores than in below-ground organs and stems, from which the latter showed the strongest response to environmental constraints. A change in community composition towards species with increased C:N ratios in e.g. below-ground organs might lead to even greater increase in stem C:N ratios, which in reverse might have effects on ecosystem properties like biomass production and decomposition rates.

A1-O5: Functional traits and environment predict vegetation responses to disturbance

Markus Bernhardt-Römermann[1], Alan Gray[2], Adam Vanbergen[2], Laurent Bergès[3], Andreas Bohner[4], Rob Brooker[5], Luc De Bruyn[6], Bruno De Cinti[7], Thomas Dirnböck[8], Ulf Grandin[9], Alison Hester[5], Róbert Kanka [10], Stefan Klotz[11], Grégory Loucougaray[12], Lars Lundin[9], Giorgio Matteucci[7], Ilona Mészáros[13], Viktor Oláh[13], Elena Preda[14], Bernard Prévosto[15], Juha Pykälä[16], Wolfgang Schmidt[17], Michele Taylor[18], Angheluta Vadineanu[14], Theresa Waldmann[17], Jutta Stadler[11]

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Disturbance is one of the most important factors structuring the taxonomic and functional composition of vegetation. Vegetation resistance or resilience to disturbance depends on local environmental conditions, further modifying the pool of species and traits. This study aims to understand how disturbance and local environment combine to affect resistance and resilience.

A functional trait approach was used to detect traits related to vegetation resistance and resilience, and trait attributes of individual species responding to disturbance. Trait approaches enable comparison of vegetation responses across biogeographic regions containing different species pools.

At 35 European forest and grassland sites, experimental disturbance was applied at five intensities. Indices for resistance and resilience were calculated, based on total vegetation cover, and related to climate and local site factors. Additional indices were calculated for the most common species to demonstrate traits that confer resistance and resilience to disturbance.

Vegetation resistance was related to occurrence of species with traits selected by a history of intensive land-use (smaller leaf size, rosette plant form), and local environmental conditions. Vegetation resilience, however, was associated with ecosystem properties that facilitate higher growth rates. Resilient vegetation occurred where irradiation was higher (grasslands, open forests) with sufficient water availability (summer precipitation, humidity) and comprised of species with traits related to enhanced growth rates (increased SLA, decreased LDMC).

This pan-European disturbance experiment demonstrates that different drivers (land-use or climate) of vegetation response show different mechanistic responses to physical disturbance. Resistance depends on the functional composition of predominant species in the assemblage, which is strongly affected by land-use history; resilience is directly connected to growth rates affected by climate.

A1-O6: Leaf trait relationships and species rankings in differently managed meadows

Laura Rose[1], Marie Carolin Vogel[1], Dietrich Hertel[1], Christoph Leuschner[1]

[1]Plant Ecology and Ecosystem Research, Georg-August University of Göttingen, Göttingen, DE

Functional traits have been identified to characterize ecosystems and predict ecosystem responses to environmental changes. Our study aims to analyze the response of three leaf traits and their relationships to land-use intensification in permanent temperate meadows.

The questions we wanted to answer were whether species-specific trait responses to land-use intensification alter the trait-based species rankings, and whether management intensification alters leaf-trait relationships.

The study took place within the framework of a full-factorial grassland management experiment (GRASSMAN) with two fertilization levels (none vs. NPK-fertilization) and two cutting frequencies (one vs. three cuttings per season) in an old-growth grassland site located in the Solling Mountains, Central Germany. We analyzed the specific leaf area (SLA) and the mass- (N_{mass}) and area-based (N_{area}) leaf nitrogen concentrations of eight grassland species.

We show that NPK-fertilization led to generally higher SLA and N_{mass} but not N_{area} values. The effect of altered cutting frequencies on leaf traits was more species-specific. Species-specific responses to management greatly altered the trait-based species rankings. A significant SLA-N_{mass} relationship did occur in unfertilized plots, whereas the SLA-N_{area} relationship was stronger in fertilized plots. This was caused by a decrease in interspecific N_{mass} variation in fertilized plots.

These results indicate that plant functional trait relationships are not as consistent between different management regimes as suggested by earlier studies. Land-use intensification has the strong potential to alter trait-based species rankings within seminatural temperate meadows by species-specific trait alterations. It also decreases functional trait variation, which is assumed to be important for ecosystem functioning.

A1-O7: Climatic context-dependent responses of grasses and herbs to environmental change

Alexandra Erfmeier[1]

[1]Institute of Biology / Geobotany and Botanical Garden, Martin Luther University, Halle-Wittenberg, DE

Climate change can induce shifts in plant communities and impact ecosystem functioning. While altered drought and precipitation levels are known to affect temperate grasslands by reducing productivity, less attention has been paid to the role of inter-annual variability on the magnitude of community responses and on differential performances of traits and functional groups in their environmental context. A 5 yrs repeated transplant experiment was conducted with grasses and herbs of Central German dry grasslands to assess effects of increased resource availability on trait expressions in these groups by taking the co-varying influence of precipitation and temperature conditions into account. Effect sizes were calculated to compare traits related to size, growth rates, allocation and fitness across study years. Positive mean effect sizes were found for root biomass and lateral expansion displaying high responsiveness to experimentally improved environmental conditions. For most of the traits, effect sizes were higher for herbs than for grasses; however, there was no significant difference in allocation and leaf-related traits. Mixed model covariance analyses with temperature and precipitation revealed that biomass and fitness related traits were negatively affected by increasing precipitation and increased with higher mean temperatures. Significant interaction effects were expressed in different slopes for the herbs and the grasses. As a conclusion, responses of grasses and herbs to environmental change differed considerably with higher responsiveness of the herb species under improved environmental conditions. However, the responses were largely affected by the particular climatic context of the respective study year. Accounting for different slopes of grasses and herbs towards environmental changes in global vegetation models can contribute at improving predictions on shifts in community composition and functioning under climate change.

A1-O8: Impact of altered water availability on germination of flood meadow species

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Following severe interventions into hydrology of rivers and their flood plains, as well as landuse changes, species-rich alluvial meadows became one of the most threatened habitats. Therefore, attempts to preserve and restore these alluvial grasslands are ongoing. Along the northern Upper Rhine the transfer of seed-containing plant material from species-rich donor sites proved to be an effective method to re-establish typical and rare species in floodmeadows.

Climate change will most likely be accompanied by more extreme climate conditions like extended periods of drought and higher frequencies of extreme floods. Although plant species typical for the flood meadows are adapted to extreme volatility of water availability, the

predicted climate changes will likely alter plant species composition of these meadows. For future conservation and restoration projects it is crucial to know how sensitive species react to these changes. Especially long periods of drought during main germination periods will potentially limit the regeneration through seeds in several species. Extended knowledge about species' reactions will allow adaptation of currently successful restoration schemes to future climate conditions.

To assess the ability of typical and rare flood meadow species to cope with changing water availability we set up an experiment where we exposed20 floodplain species to 5 different water potentials (0 to –1,5Mpa) and recorded seed germination over a period of 7 weeks.

Preliminary results indicate that species with low water requirements have highest germination rates when exposed to those altered water potentials.

A1-O9: Wood density responses to climate and an intertidal gradient

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The majority of forest biomass is allocated in wood stems, consequently wood constitutes a primary carbon sink. Few studies have addressed the effect of environmental and climatic conditions on wood density, which may influence the carbon sink provided by forests.

We studied the relationship between wood density and wood anatomy of *Avicennia marina* (a widespread mangrove species) in sites with contrasting temperature and rainfall conditions and in seaward and landward forests. We tested the hypotheses that trees from dry and warm sites would have denser wood with less conductive area and thicker fibre walls than trees from high rainfall and cold sites. Over our intertidal gradient we expected that trees from the landward sites have higher phloem content than trees from the seaward site.

We found that wood density is sensitive to climate. Trees from the cool, high rainfall site exhibit low wood density, that is linked to low conductive areas and thin fibre walls. Low conductive areas in a site where freezing occurs may be important to reduce embolism vulnerability. Alternatively, trees from the arid site form high dense wood positively related to fibre wall thickness, but negatively associated to conductive area. Thick fibres in a dry site may play a water storage role. Additionally, high phloem content within the wood of *A. marina* was evident in the landward forests, suggesting a role for tolerance of enhanced salinity or drought.

A1-O10: Aggregative response of bats decrease by space filling

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[2]Technical University Munich, Freising, DE
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1. Mobile predators have the option to show an aggregative response to prey by concentrating in areas of high prey abundance.
2. Forestbats are highly mobile, insectivorous, and non-territorial foragers. We examined the effects of prey abundance on foraging activities of three guilds of bats (open-habitat foragers; edge-habitat foragers; and closed-habitat foragers) during 7 nights at each of 42 sites. Bat activity was measured by batcorders (38,371 call sequences), and prey abundance was estimated concurrently at each site using light and pitfall traps. We also examined the effect of temperature and space filling measured by terrestrial laser scanning on the foraging activities.
3. Direct and indirect effects of prey abundance on each guild were estimated using path analyses. We then fitted a linear mixed model to test the prediction that the response of bat activity to increasing prey abundance is increasingly independent of temperature and habitat structure, from the closed-habitat foragers to the open-habitat foragers.
4. The data confirmed our prediction and support the hypothesis that only bats of the open-habitat foraging guild respond aggregatively to prey. Our results support the view that in forests with a complex vegetation structure, the accessibility constrained by the bat’s sensory ability and morphology is more important for bats than the prey abundance per se, and the response is related to the behaviour of information transfer of the bat species. The results further support the general view that the importance of an aggregative response of predators increases from complex to simple habitats.

A1-O11: No age effect on the functional redundancy of carabids after a severe flood

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Functional redundancy (FR) is based on the observation that some species perform similar roles in ecosystems and may be substitutable with little impact on ecosystem processes. There is, however, contrasting perception, as in most cases low or no FR was observed and almost nothing is known about the role of FR after severe disturbances. Here we analyze FR of ground beetles after an extreme flood and test if FR can enhance resilience. Ground beetles were sampled directly after an extreme flood from 2002 until 2005 at the Elbe River in Central Germany. On each plot FR was measured as the difference between the total species number and the average number of species leading to an increase in functional diversity. We used autoregressive mixed effects models to test whether highly redundant communities are more resilient than non-redundant communities. FR differed markedly across space and time, as it was significantly higher in spring than in fall, but also higher in habitats which are regularly flooded. As expected, FR was lowest immediately after the 2002-flood but quickly increased in the following year. We found, however, no clear evidence that FR is a driver for post-flood resilience (measured as functional diversity), because an increase of FR caused decreasing resilience. Results suggest that long-term conditions rather than stochastic events drive the necessity of species to be redundant. We further assume that high FR is linked with the amount of resources provided by a given habitat or in a given season, because FR was low or quasi non-existent when prey density is usually low. The contrasting results for resilience imply that the similarity of certain traits, rather than trait diversity, is important for co-occurring species in frequently disturbed habitats. Although this finding supports recent trait filtering theories, it depends strongly on the definition of resilience.

A1-O12: Effects of environmental warming on trophic interactions

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Over the next 100 years the mean annual temperature might increase by 1 to 6 °C with weather extremes such as heat waves or heavy precipitation becoming more frequent. Many ecologists strive to predict the impact of climate change on ecosystems, communities and the trophic interactions between species in a complex food web. Ecosystems are highly complex, and for predicting the consequences of global warming it is crucial to understand the mechanistic principles how temperature affects the strength of pairwise interactions. Trophic interactions between consumers and their resources build the energetic backbone of natural communities and are mainly driven by feeding and assimilation. The influence of temperature on feeding rates can be investigated by laboratory experiments using a Holling functional response approach. Assimilation efficiency describes how much of the ingested energy is absorbed and used for maintenance and growth of an individual, thus being an important parameter in calculations of energy fluxes between species. We conducted functional response experiments with up to four predator individuals to not only investigate the effects of temperature on a single species' feeding rate but on intraspecific interference competition. Interference competition showed a complex response in predator behaviour depending on the predators' metabolic rate, which depends both on bodymass and temperature. Subsequently, we established an assimilation efficiency database which we analysed for feeding habit and temperature dependence showing that assimilation efficiency depends on the feeding habit but is temperature independent. Together, these findings can contribute substantially to systematic predictions on the effects of climate change on ecosystems and population dynamics.

A1-O13: Impact of environmental change on plant-species interactions of herbivores

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The northeastern lowland (Nordostdeutsches Tiefland) is historically and currently a mass outbreak area for a series of forest pest species. This applies especially for the federal state of

Brandenburg with regard to local soil and climatic conditions, and the dominance of pine forests (*Pinus sylvestris*). Due to increased risk factors and for the prevention of irreversible stand loss to caterpillar, feeding on pine needles, a continuous standardized monitoring proceeding is applied to enhance the potential of a forecast and control.

Caterpillar of pine forests like the European pine moth, *Dendrolimus pini* (Lep., Lasiocampidae), and the pine looper moth, *Bupalus piniarius* (L.), show species specific cyclic oscillations. As a consequence of climate change these caterpillar species develop variation in population dynamics attributed to shifts in environmental factors during recent decades. Lepidoptera regionally play major roles in pine forest growth of the northeast German landscapes and generally population dynamics and the individual tree growth respond to climatic factors. This work describes the change in tree growth and population traits with regard to climate warming, which may explain the cyclic occurrence and the chronological sequence of the outbreaks. Data bases of 1951 to 2010 were analysed and compared with climate, location, and forest traits on a landscape and stand type level.

Poster Presentations

A1-P1: Stomata number and length – useful traits for phenotyping drought response?

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Climate projections estimate rising temperatures and decreasing precipitation for subtropical and mid-latitude regions. The local species thus have to adapt to new conditions, for example longer and more frequent periods of drought. In this study we used European silver fir (*Abies alba* Mill.) as a model species. It is distributed in mountainous and sub-alpine regions of central and southern Europe and is supposed to be affected by climate change in the future.

We investigated the morphological traits stomata number and stomata length for variability and differences among micro-sites with contrasting environments. The study was conducted in the Black Forest at two locations with each two plots. The plots were placed up- and down-hill thus assumed to exhibit contrasting levels of soil moisture. Due to the nested design a hierarchical linear mixed-effects model was chosen for data analysis.

The results showed contrasting patterns of variation. While the number of stomata was similar on all hierarchical levels, stomata length revealed considerable variability, especially among individuals but also among locations. We concluded that the number of stomata was probably rather genetically fixed and that stomata length exhibited greater phenotypic plasticity. A better knowledge about which phenotypic traits may be relevant in stress response will be useful to assess the potential of forest ecosystems to cope with the effects of climate change.

A1-P2: Biodiversity effects on plant stoichiometry

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Within the Jena Experiment we analyzed the relationship between plant diversity and the stoichiometry of multiple elements in plant tissue. Biodiversity and ecological stoichiometry will be related if different species absorb various elements with different efficiency or show specific chemical compositions. Across the gradient of plant diversity and species composition, the bivariate ratios of Carbon, Nitrogen, Phosphorus and Potassium in the plant community were analyzed. We tested whether plant diversity changes the relative content of multiple elements on the community level. Furthermore, we analyzed how species diversity affects multielement stoichiometry and the predictability of chemical composition. Based on monoculture ratios, we tested whether the mixture is more stoichiometrically confined simply by a mixing effect.

Sown diversity (both species and functional groups) affected the bivariate ratios, with increasing effect size of time. Diversity strongly affected P-ratios (C:P, N:P, P:K), whereas legume presence affected all N-variables, but also other ratios. Furthermore, higher diversity was always and strongly related to lower variability in bivariate ratios. Using a multivariate analysis across all 4 elements, we found that increasing sown diversity related to more balanced community biomass chemistry. This has potentially strong consequences for primary consumers of the plant material.

A1-P3: Leafhopper diversity on calcareous grasslands of different size and isolation

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Calcareous grasslands belong to the most species rich habitats in Central Europe. However due to agricultural intensification they became highly endangered due to abandonment or conversion to arable land. We investigated impacts of decreasing fragment size and increasing isolation of fragments of calcareous grasslands in southern Lower Saxony. We focused on leafhoppers and planthoppers (Auchenorrhyncha) since they are very abundant plant suckers with close relationship to the vegetation structure. Further, they include many specialist and little mobile species that are likely to sensitively react to changes in their environment. We chose 14 large (2-8 ha) and 14 small fragments (<1 ha) of calcareous grassland in the

surroundings of the city of Göttingen, differing in isolation from the nearest grassland fragment. Sampling was done via sweep netting on six transects per site in June, July, August 2010. A total of 81 leafhopper species were found with a maximum of 33 species per fragment. Richness and density of the species were related to the distance to the nearest fragment. In contrast to expectations, the number of specialist species did not differ between large and small sites, whereas on small sites there were more generalists than on large sites. The decrease in species richness and density with increasing isolation may be due to the limited dispersal capability of many leafhopper species. Specialists confined to calcareous grasslands may have particular difficulties in reaching the next suitable site, being unable to use alternative plant resources during dispersal. The higher number of generalist leafhoppers caught in small sites appears to be due to an increase in edge effects with decreasing patch size. Biodiversity therefore seems to be affected by grassland connectivity not area, emphasizing the need to maintain stepping stone habitats within the landscape, to allow spillover among habitats.

A1-P4: Germination traits of *Datura stramonium* in Kosovo

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Datura stramonium L. is a problematic weed in arable crops of Kosovo. In a recent region-wide vegetation survey, it has become obvious that *D. stramonium* is more frequent and/or reaches higher abundances in the western than in the eastern part of the country, and this might go hand in hand with differences in land use and/or climate differences between these two sub-regions of Kosovo and/or differences in germination traits of *D. stramonium* populations. In this context, our study provides information on temperature requirements for germination of non-stratified and stratified seeds of *D. stramonium* originating from the two sub-regions. In each sub-region, seeds from five populations were harvested. We conducted a seed germination experiment in climate chambers at temperatures ranging from 15 °C to 30 °C. In the experiment, we used pretreated (cold stratification) and non-pretreated seeds. The results showed that the germination rates slightly differed between pretreatments (with vs. without cold stratification) and provenances (western vs. eastern part of Kosovo). Most of the seeds originating from the western part of Kosovo had higher germination rates and required a lower temperature for germination than seeds originating from the eastern part.

A1-P5: Does floral colour structure plant communities in temperate grasslands?

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Flowers pollinated by insects and other animals depend on attractants like colours and scent to draw pollinators. Considering the colour diversity of a rich flowering grassland it seems obvious to hypothesise that floral colour divergence is non-random and of adaptive significance.

Selective pressures may have favoured divergence of flower colours to promote flower constancy of pollinators. However, especially rare plants may profit from convergence on the flower colours of common species to avoid receiving only exploratory visits from pollinators. To assess whether the assemblage of flowering plants is based on patterns of divergence or convergence in flower colours of rare and common plants, we collected data on blossom cover and flower reflectance spectra of flowering herbs in three different sites in Germany. We analysed reflectance data of colours as they are perceived by bees and studied the floral colour composition of 54 plant communities based upon flower colour loci of each plant species in bee colour space. First results revealed that the occurrence of rare plant species is not determined by divergence or convergence on sympatric and simultaneously flowering common species. Thus, in contrast to previous studies our results suggest that plant communities of temperate grasslands are not structured by a strong selective pressure on the flower colour of rare plants to secure pollination in the presence of common plants.

A2 Coexistence and dominance of plant functional types

Oral presentations

A2-O1: Plant functional types in *Nardus* grasslands

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Nardus-grasslands are a characteristic element of the cultural landscape in siliceous low mountain ranges. They are protected as priority natural habitat by the EU habitats directive 92/43/EEC. These low-productive pastures are increasingly being abandoned or afforested in the Central and Southern Black Forest. Depending on the differing land use, the vegetation type varies in structure and species composition. We studied the response of the vegetation on land use applying the concept of plant functional types. The vegetation types were classified by land use intensity and vegetation structure. The plant species were classified by ten selected functional traits. The traits were gathered from the LEDA traitbase. They were selected in relation to the pasture regime and in dependence on correlations among the traits. Leaf area, specific leaf area, canopy height, clonal growth, seed mass and woody shoots are the most important criteria. The abundance of the resulting eight plant functional types was studied in five different pasture types by a multivariate analysis. Functional types which were defined by lignified stems or by high input in leave tissue showed a well defined response to land use. Other functional types e.g. defined by intermediate values in specific leaf area (SLA) were almost evenly distributed across different vegetation types.

A2-O2: Shift of coexistence patterns during secondary succession in a fallow central European wet grassland

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The long-term (25 y) secondary progressive succession in abandoned fen grasslands (Calthion) can be described as a turn-over process of different functional types. In the initial succession phase of three to five years a fast increase of tall growing, rhizomatous, deciduous reed species (e.g. *Phalaris arundinacea*) occurrs. This strongly changes vegetation structure and within-canopy light climate which is the reason for decreasing species diversity. Rhizomes are hypothesized to be a key factor of high competitiveness in abandoned wet grasslands because it combines multiple advantageous functions: low-risk vegetative propagation, nutrient storage and nutrient re-allocation between above- and below-ground plant organs allow for a gradual build up of a high biomass. Extinct grassland species (e.g. *Senecio aquaticus*) represent a contrasting set of plant traits such as small stature, short lifespan, prevailing generative reproduction and ever-green leaves. The subsequent succession phase commencing about five years after mowing was ceased is characterized by the persistence of the established reed vegetation which prevented tree colonisation until today. The plant functional types concept is promising in understanding secondary successions in abandoned wet grasslands if one considers changes of the habitat (esp. light climate), the presence of reed species with a specific set of plant traits in the "Initial Floristic Composition" and their potentially high competitive vigour.

A2-O3: Species interaction in experimental communities composed of one functional group

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The particular value of biodiversity consists of its capability to increase process rates like productivity, these positive effects are thought to be caused by both complementarity and facilitation of coexisting species. Coexistence driven by complementary resource use or beneficial effects from one species to the other requires functional differences among the species present. Functional differences are commonly assumed to be higher among than within functional groups, thus, niche differences are supposed to be more pronounced among but not within groups. However, several studies found that species diversity within group also affects ecosystem functioning, and thus, emphasized that species of one functional group are not functionally redundant. We studied diversity-productivity relationships in experimental communities composed of species representing one functional group only. We chose frequently occurring species from subtropical Southeast China which are fast growing tall annuals of different plant families and established a total of 160 communities, composed of 25 different species combinations, with diversity levels from 1 to 8. While some of the species displayed significant overyielding, others showed no such trend. Instead of a general positive diversity-productivity relationship we found the prevalent importance of community composition confirmed by particular species identity effects. The present study demonstrated that small-scale species differences are capable to increase ecosystem functioning to a certain extent via species identity effects. The relative performance of species within communities increased for species weakly performing in monoculture and was mitigated for strong performers in monoculture. We assume that altered species performance was derived by shift in competitive ability as a function of diversity level. As a conclusion, there is some evidence that small-scale complementarity occurs even within a single functional group.

A2-O4: Is pollinator-mediated selection modified by conspecific plant density?

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Both variation in local plant density and differences in plant phenotypic traits are known to influence pollinator behaviour and subsequent plant reproductive success. Little, however, is known about how local plant density mediates patterns of trait selection via changes in pollinator activity. We therefore examined how conspecific plant density and traits interact to determine pollinator behaviour and plant reproduction, using the self-incompatible, perennial forest herb *Phyteuma spicatum* as model species. Specifically, we hypothesized that limited pollination service in more isolated plants would lead to increased selection for traits that attract pollinators. Selection gradients (i.e. trait-fitness relationships) were assessed in two natural populations of varying density and pollinator observations were conducted in one population. Both local density and plant phenotypic traits affected pollinator foraging behaviour. At low plant densities, visitation rates were overall low, but increased with increasing floral display size, while this relationship disappeared or even reversed at high densities, where visitation rates were generally much higher. This density-dependent pollinator behaviour, however, did not translate into density-dependent patterns of selection. Still, we detected selection for an increased inflorescence size and an intermediate flowering time, and selection seemed at least in part to be mediated by pollinators. Our results underline the importance of taking both conspecific density and plant phenotypic traits into account when examining effects on pollination and plant reproductive success and, albeit not detected here, point to a potential mechanism for small-scale spatial variation in selection on plant attractive characters.

A2-O5: Climate change response of alpine plants is limited by narrow germination niche

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Seed germination is high-risk phase in a plants life cycle, and is directly regulated by temperature. Consequently the breadth of germination niche regarding to temperature can predetermine the species‘ ability to react on climatic changes: species with broader germination niches are able to react faster on climate changes than others with narrow germination niche.

To estimate the potential reaction of species occurring in the Bavarian Alps (Germany) to future climatic changes, the following study was carried out. Dormancy-breaking conditions as well as germination rates along a temperature gradient (10/2, 14/6, 18/10, 22/14, 26/18, 30/22°C) were studied for 62 most common in the research area species with different altitudinal distribution.

The analysis of dormancy-breaking conditions showed that with increasing altitude the proportion of species with dormant seeds increased. Moreover, the grade of dormancy also increases: some species (e.g. *Gentiana verna* L., *Campanula scheuchzeri* Vill.) required cold stratification for longer than 3 months. Successful regeneration from deep-dormant seeds can be strictly limited if, due to climatic changes, winters will be shortened, and as a result, dormancy cannot be broken anymore sufficiently.

We also demonstrated that alpine species had a narrower germination niche than lowland species. The optimum temperatures for germination of alpine species lie in the range from 18 to 30°C, while lowland species germinate under all experimental temperature conditions. High temperatures (30/22°C) were also a limiting factor for germination of some alpine species.

A2-O6: Germination ecology of dry sandy grassland species along a pH-gradient simulated

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Species occurring along a soil pH gradient show different responses to acidic and calcareous conditions. We studied Aluminium (Al) toxicity, because it is a possible major factor limiting plant growth in acidic soils.

Germination and root growth rate of dry sandy grassland species (from a gradient of very acidic to calcareous sandy soils and with different EIV) were examined along a simulated gradient of Al availability with the aim of showing that species exclusively occurring in calcareous (high pH) sandy grasslands are more sensitive to high Al concentrations than species from acidic sandy grasslands.

16 species of calcareous, intermediate and acidic dry sandy grasslands and 4 species non-sensitive to pH were chosen representing Ellenberg indicator values (EIV) for reaction from 1 (growing on very acidic soils) to 8 (growing on calcareous soils) . EIV's were additionally validated by analysing pH and Al-content in soil samples collected in the field. Al toxicity or Al tolerance was analysed by applying 10 Al concentrations from 1mM to 10 mM.

Germination and absolute root growth (ARG) as well as length of the root hair zone were studied and a critical concentration for each species was determined for ARG and length of the root hair zone.

The results confirmed the hypothesis that acidic grassland species are more resistant to Al in comparison to intermediate and calcareous grassland species. As for germination, Al generally reduced germination rate but no differences were found between acidic and calcareous species.

As for root reactions, in high concentration of Al not only root growth was strongly reduced, but also typical symptoms like swollen and brown-coloured root tips or short stunted curved side roots were observed. Different critical concentrations were found for acidic, intermediate and calcareous species.

A2-O7: From competition to mutualism: how stress influence species cooperation

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Anthropogenic stresses and climatic changes have the potential to strongly reduce species richness entailing the loss of the provision of valuable ecosystem services. In this study we investigated functional shifts and the role of biodiversity using laboratory mesocosms composed of 12 bacterial species growing on benzoate as their sole carbon source. Half of the species were directly capable utilizing benzoate while the other half only could survive on metabolic intermediates of degrading species. Starting with assemblies of all possible species combinations and we estimated the occurring of bacterial growth for each combination. Next we simulated random extinction events by stepwise removing single species. As soon as the communities lost the last degrader they rapidly shifted from a benzoate degrading community toward one that was no longer able to provide this function. To better understand the role of species interactions for the provision of the ecosystem function under stress we additionally conducted the same extinction experiments under two successive stress levels. Firstly confronting the communities with 6 times higher benzoate concentration having a toxic effect even on many benzoate degraders. In a second step additionally 15 g/l NaCl was added. Under the combined stress none of the species was able to grow as a monoculture, however many polycultures were able to survive. Non-degrading species that were seemingly unimportant under none and/or benzoate stress suddenly became a prerequisite for the functioning of a community at highest stress levels. Detailed analysis comparing similar extinction rows allowed us to determine multiple species combinations which occurred to be minimal communities necessary for the provision of benzoate degradation within our microcosms. From our experiments we can directly show that while competition was the main species interaction under no stress systems in highly stressed systems mutualistic species interactions dominated.

A2-O8: Grassland-woodland-mosaics in prealpine large extensive grazing systems

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Semi-open landscapes consist of a mosaic of grassland and woodland patches, where vegetation types are linked by progressive and regressive successions. While tree establishment on grassland initiates forest succession, the decay of mature trees gives way to the (re-) establishment of grassland.

In middle Europe, semi-open landscapes that emerge from extensive grazing are known to be rich in biodiversity and of high value for nature conservation. Though often protected by law, such wooded pastures are threatened by land use change and are suspected to be very vulnerable to climate change. Reforestation and fallow succession after grazing extensification or abandonment is their major threat. Furthermore, climate warming is expected to alter grassland productivity and growth rates of trees, which impacts on the balance of progressive and regressive successions and thus on the landscape mosaic.

Two modeling approaches are applied to investigate the dynamic coexistence of grasses and trees in the grassland-woodland-mosaic of large prealpine extensive grazing systems with respect to land use and climate change: a model of tree line ecotones emerging from Alder encroachment on fens due to undergrazing and a compartment model of long term dynamics of woodland and grassland vegetation types on pastures. At ecotone level, tree encroachment on grassland is shown to be an *event-driven* process and progressive successions to be dependent on *tolerance* strategies of tree species and *inhibition* by grasses. At pasture level, long term dominance shifts between grassland and woodland are shown to be very sensitive to the grazing regime, climatic extremes and climate warming.

In the outlook, the combination of both modelling approaches is discussed to elucidate potential resilience of the coexistence pattern and thus landscape structure in wooded pastures to land use and climate change.

A2-O9: Differentiation of plant functional traits in an initial catchment succession

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Pattern of species distribution and composition are substantial structures of vegetation. Vegetation patterns may be differentiated in terms of plant functional traits. The traits themselves may impact the subsequent vegetation patterns and subsequent succession trajectories.

The artificial catchment *Hühnerwasser* (a 6 ha catchment in a lignite mining reclamation area south of Cottbus, northeast Germany) started with nearly homogenous spatial conditions and underlay successional processes since the construction end in 2005. During a five year period the vegetation stride through different successional steps resulting in spatio-temporal pattern. We present pattern analyses to answer the following questions: How the first fairly homogenous initial state has evolved after five vegetation periods? Do functional plant traits represent the time-series which resulted in spatial pattern? Which abiotic factors mainly explain the pattern development?

A2-O10: Coexistence and dominance of plant functional types – some conclusions and outlook

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An attempt is made to summarize the results of the session "Coexistence and dominance of plant functional types" and to give an outlook on the further potentials of this concept. The overview depends on common criteria such as the level on which plant functional groups are established, on the parameters employed to distinguish these groups and the functionality of selective forces and plant life traits.

Poster Presentations

A2-P1: Vertical segregation of vascular epiphytes and the regeneration niche

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Vascular epiphyte assemblages show a pronounced vertical stratification within a given forest. This stratification is often associated with the microclimatic gradients that can be found within forest stands. Surprisingly, it has rarely been explicitly investigated whether the heights at which different species occur within a forest (and, thus, the average microclimatic conditions they experience) indeed coincide with their autecological optima. The interplay of germination and seedling growth and varying environmental conditions should play an important role in determining spatial distribution, justifying a focus on these early life stages.

We are relating differences in the optimal conditions for germination and seedling growth of a set of species out of two important vascular epiphyte families (Bromeliaceae and Araceae) to their spatial distribution within the forest. Data on the spatial distribution of the species - as well as seed material for the germination and growth experiments - stem from the lowland rainforest at the San Lorenzo crane plot, Republic of Panama, where we conducted a census of all vascular epiphytes within an area of 0.4 ha. The environmental factors to which we measured the biological response are water supply and, in case of the bromeliads, also temperature.

While there are no results for the aroids available yet, our results for 5 species of bromeliads indicate a close match of spatial distribution and the species microclimatic optima. This lends support to the hypothesis that spatial distributions are determined very early in the ontogeny of vascular epiphytes.

A2-P2: Functional types of vascular epiphytes: moving towards spatial-temporal models

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Vascular epiphytes are a conspicuous und important component of the tropical and subtropical flora, contributing approximately 25% to tropical vascular flora biodiversity worldwide. However, they have largely been neglected in ecological modelling, partly due to a lack of appropriate data for model validation or parameterization. A long-term monitoring project in Panama now provides a unique dataset that supports model calibration and/or validation. Our main goal is to develop different simulation models, e.g. individual-based and population-based models, which can describe spatial-temporal distribution of individuals and epiphyte (meta-) population dynamics. For this purpose and to assess the dynamics of a large variety of epiphyte species, it is essential to initially categorize vascular epiphyte species into functional types that are useful for our modelling purposes. Thus, in a first step, we revised available categorizations of epiphytes and obtained a set of 20 functional traits by which we classified the 136 species of the study area (Panama). In addition, we identified which functional types have already been studied adequately in regard to their population dynamics, giving independent parameter estimates for model validation. In a second step, we developed a detailed concept of an individual-based model that incorporates environmental factors, considers aspects of forest dynamics and simulates the above mentioned functional traits. This modelling concept offers a starting point for the integration of vascular epiphytes in the ecological modelling agenda. Hence, upcoming process-based models will allow addressing ecological issues that have been scarcely investigated, such as how vascular epiphytes vary in time and space.

A2-P3: Interaction of growth systems of selected sedum-species in man-made habitats

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Plants influence each other - below ground and above ground. This creates regular-like combinations of species in natural rooms. In man-made habitats such as the extensive green roof areas are species composed, which do not occur in natural habitats. Accordingly is little known about the interactions of the shoots and geophilic systems in these artificial plant communities. The purpose of our research project is to determine the species-specific growth patterns of indigenous wild sedum species and understand their interaction processes in artificial plant communities. Growth form analysis will reveal the development of the above ground and below ground systems of Sedum species (Meusel 1935, Stöcklin 1992, Pütz 1998) and effects of interactions on the above ground and geophilic systems will be studied in simple pair wise design (Schreiber 1967, Remison & Snaydon 1980). For this, plants are individually cultivated as well in mixed stands over three years on a roof area of the University of Vechta (Germany). To highlight the species-specific growth pattern, the behaviour of the species on the roof will be compared with species in natural habitats. Based on this, the results can be used for optimization in constructing natural and site-specific socializations in artificial habitats.

A3 Physiological Plant Ecology - From ecological patterns to physiological mechanisms

Oral Presentations

A3-O1: Survival without water - microbial crusts as hydration specialists

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Microbial crusts, composed by lichens and bryophytes, are increasingly recognized for their important roles i) in biogeochemical cycling, ii) in vegetation-atmosphere exchanges and iii) as pedosphere-atmosphere interface by soil cover (Lakatos et al. 2007). Moreover, rough estimations attributed 6% of the global terrestrial net carbon uptake to microbial crusts. Despite this ecological impact, CO_2 and water exchange processes of non-vascular plants are yet not well understood from the stable isotope viewpoint. In contrast to vascular plants, poikilohydric organisms are not able to regulate their carbon gain and water balance actively – both processes are passively controlled by their structure and environmental conditions, but particularly by water availability. The stable isotope composition of water is routinely used as a tracer to study water exchange processes in vascular plants and ecosystems. To date, only one recent study focussed on isotope processes in lichens to understand their basic isotope exchange processes during dehydration indicating that lichens equilibrate with the isotopic composition of surrounding water vapour (Hartard et al. 2009).

We will present a novel model as a proof of concept that accounts for the specific water relations of poikilohydric organisms. Moreover, the impact of cryptogamic vapour exchange on the ecosystem will be discussed. The results represent first steps towards the development of poikilohydric organisms as a recorder of ambient vapour isotopic composition.

A3-O2: Ecophysiological analysis of distribution patterns of moss-dominated soil crusts

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Biological soil crusts, consisting of cyanobacteria, algae, fungi, lichens, and mosses in varying proportions, inhabit the uppermost millimetres of the soil, occurring regularly in arid and semiarid regions around the world. They agglutinate soil particles, thereby effectively reducing erosion, bring nutrients into the strongly depleted soils and promote plant growth.

Moss-dominated soil crusts (mainly consisting of *Ceratodon purpureus*) were investigated in the semiarid region of the Succulent Karoo, South Africa. Within the study area we found a gradient from abundant moss vegetation towards the almost complete lack over a distance of only 5 kilometres. Along this gradient the meso- and microclimatic characteristics experienced by the soil crust (temperature, light intensity, water conditions) were monitored with four climate stations in 5-minute intervals over a whole year. The results revealed drier conditions and increasing temperatures towards the moss poor region of the gradient.

In a second approach, the physiological characteristics of *Ceratodon purpureus* with regard to water-, light- and temperature conditions were analyzed by means of gas exchange measurements in a factorial analysis in the lab. These measurements revealed that *Ceratodon purpureus* has a rather narrow range of optimum water conditions and is severely limited by temperatures above 27°C. A combination of the microclimate and gas exchange data illustrated the climatic gradient to be largely responsible for the observed distribution patterns.

Future climate scenarios for the Succulent Karoo predict the local climate to become drier and hotter during the next decades. This implies for moss-dominated soil crusts to become largely repressed from the Succulent Karoo. Due to the role they play in soil stabilization and vascular plant growth, their repression may also put a major threat on the present vascular plant vegetation.

A3-O3: Does climate change render tropical rainforests into bryophyte deserts?

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Bryophytes (mosses and liverworts) are an important component of tropical forests and could be strongly impacted by climatic changes. Warming could force bryophytes uphill and - in a worst-case scenario - cause their complete disappearance from tropical lowlands, where they are already rare compared to higher altitudes. This surprising observation is usually explained by high respiratory losses at night, which can hardly be balanced by daytime CO_2 uptake (*A*) because of reductions in *A* by super or supraoptimal water contents. The present work analyses the physiology of a range of species from the lowlands and montane areas.

For a range of moss and liverwort species from three altitudes (sea level, 500m, 1100m) in Panama we studied the response of *A* to varying thallus water content, light and temperature. First results of a carbon balance model based on the measured response curves and bryophyte hydration kinetics suggest that elevated temperatures will substantially reduce daily carbon gains. This is due to faster drying and lower carbon uptake during the day, as well as increased respiration rates and higher carbon losses at night. Theoretically, the increase in respiration could be compensated by acclimatization, but the acclimatization potential of tropical bryophytes was so far unknown. We therefore transplanted three bryophyte species from 500m to sea level and measured the temperature responses of respiration and photosynthesis. In contrast to the expected “adaptive” response, after three months at higher temperatures respiration in these bryophytes had increased. Acclimatization thus does not appear to be able to alleviate the negative effects of warming on bryophyte carbon balances.

The current evidence thus suggests lower carbon gains in lowland bryophytes in the future, which may leave the lowlands all but devoid of this life form.

A3-O4: Effects of severe drought on multiple ecosystem functions in temperate grassland

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Studying the effects of extreme weather events such as drought on ecosystem functions is one of the most important facets of climate change research. Rarely, however, are multiple properties measured in a single study across different categories of responses. We set up a long-term field experiment, where we applied recurrent severe drought events annually for six consecutive years to constructed grassland communities in central Europe. The 32 response parameters are related to primary production, nutrient cycling, carbon fixation, water regulation and community stability.

Surprisingly, in the face of severe drought, above- and below-ground primary production of plants remained stable across all years of the drought manipulation. Yet, drought significantly reduced below-ground performance of microbes indicated by reduced soil respiration, microbial biomass, cellulose decomposition rates and mycorrhization rates. Drought reduced leaf water potential, leaf gas exchange and leaf protein content, while increasing maximum uptake capacity, leaf carbon isotope signature and leaf carbohydrate content. With regard to community stability, drought induced complementary plant–plant interactions and shifts in flower phenology, and decreased invasibility of plant communities and primary consumer abundance.

Our results provide experimental evidence that climate extremes initiate plant physiological processes, which may serve to regulate ecosystem productivity. We assume a temporal hierarchy of patterns of fast versus slow response. Such data on multiple response parameters within climate change experiments foster the understanding of mechanisms of resilience, of synergisms or decoupling of biogeochemical and physiological processes at the ecosystem level.

A3-O5: Effects of arbuscular mycorrhiza on competition and facilitation between plants

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Arbuscular mycorrhizae (AM) affect composition and productivity of grassland plant communities and thus play a major role in diversity. AM fungi establish common mycelial networks (CMN), which interlink plant individuals and thus are able to distribute resources among different host plants. Although AM fungi potentially alter plant-plant interactions as competition and facilitation, little is known about the regulation of C-costs and nutrient benefits of involved plants. In an ongoing study we aim to disentangle cost/benefit ratios of mycorrhizal symbiosis for interacting plants. The impact of AM on competitive interactions between two common European grassland species (*Plantago lanceolata* and *Hieracium pilosella*) was examined in controlled pot experiments evaluating interspecific competition for mycorrhizal and non-mycorrhizal plants. Potential facilitation of seedling establishment via an established CMN was tested utilizing split-pot design with root excluding mesh barriers, allowing hyphae to pass. Indeed, analysis of biomass, extraradical hyphal density and C/N ratio indicated a facilitation effect of the CMN on seedling establishment by both species. Moreover, *H. pilosella* showed a higher facilitative potential than *P. lanceolata*, possibly due to a higher carbon investment into the CMN. Further, we found that competitive interactions differed between mycorrhizal and non-mycorrhizal plants, showing a decrease of mycorrhizal benefits in competition for *H. pilosella*, while beneficial effects on *P. lanceolata* remained unaffected. This indicates that the balance between mycorrhizal costs and benefits of *H. pilosella* is altered by the presence of a second host plant within the CMN. However, the results of both experiments suggest, that *H. pilosella* is investing considerable amounts of carbon into the CMN. The consequences of this behaviour for cost/benefit ratio of the symbiosis require further investigation using ^{13}C labelling techniques.

A3-O6: Affect of masting on carbon reserves in different tissues of *Fagus crenata*

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Reproduction often occurs at the expense of other plant life-history functions such as growth if resources are limited. Especially, fruiting in masting species is generally assumed to drain stored carbon reserves, potentially contributing to the observed oscillating pattern of masting events. Only very recently, fruit developments have been shown not to depend on carbon reserves, but to exclusively supply from current photoassilimates. However, it is not fully understood if mast seeding affects carbon reserves. Here we traced seasonal and interannual variations in non-structural carbohydrate (NSC) in branchlets, stems and roots of *Fagus crenata* between 2005 and 2009 including three masting events.

In comparison with younger twigs and tree rings in stems and roots, NSC was lower in its respective older tissues. In twigs and stems, starch concentrations increased within growing seasons and dropped to its spring level after leaf-fall. In contrast, starch concentration increased in roots. Mast seeding resulted in temporal decreases in starch concentrations in stems and roots but not in branches within a growing season. After the masting year, starch concentration increased every year in roots but not in stems. There results suggest that masting events affected the NSC reserves at individual tree level in *F. crenata*; and NSC reserves seemed to recover after masting event. Branchlets and stem contained larger NSC reserves than roots. However, when both intra- and inter-annual fluctuation patterns of the

NSC reserve were considered, it suggests that aerial parts act as temporal storage spaces for carbon and root was the main storage tissue to prepare for long-interval events such as masting. Together with the results that NSC for fruits is exclusively supplied by current photoassimilates, these results suggest that NSC reserve is prepared for growth and maintenance in masting years because of the priority of supplying current photoassimilates to fruits.

A3-O7: Is early season frost determining upper limits of European broadleaved trees?

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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 temperature means, temperature extremes might be key for climatic boundaries of tree species. Especially the cold climate (upper) limit of broadleaved tree species might be shaped by episodic frost events during early growing season. In a current project, we are assessing freezing resistance of eight major European broadleaved tree species at their upper distribution limit during the dehardening period (before and after bud break), when trees are very active and late frost events are likely. Branch samples were collected from the uppermost populations of each species in the south-western part of Switzerland on a weekly basis from mid-March to the end of May. Samples were simultaneously frozen with seven computer controlled freezing chambers. Slow cooling and re-thawing rates (3 K h^{-1}) were applied and samples were kept for four hours at the target freezing temperature, ranging between -3 and -35 °C. Survival (LT_{50}) of samples was analysed visually and by the electrolyte leakage method. The measured freezing resistance of tissues enables the assessment of critical temperatures for the specific upper limit of the investigated tree taxa during early season. These results are compared with temperatures recorded *in situ* as well as with long-term temperature records. This study will contribute to a mechanistic explanation for broadleaved tree species distributions in Europe and thus, will provide the required ecophysiological reference for modelling the potential range of these species.

A3-O8: Intra-specific variability in frost hardiness of *Fagus sylvatica*

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Frost is one of the most important environmental factors limiting the distribution of plants. Species with large geographical distribution ranges are known to show ecotypical differentiation among different sections of the range. We asked whether this differentiation does also apply to resistance to frost injuries, using the widespread and economically important tree species *Fagus sylvatica* as a model species. We hypothesized that different provenances of *F. sylvatica* differed in frost hardiness. We also tested whether winter frost hardiness of provenances is reflected in the climatic conditions of the source populations. We made use of a 17 year-old provenance trial established by Rosenfeld near to Kiel and selected 20 provenances that covered the total range of climatic conditions in the distribution area of *F. sylvatica*. Frost hardiness was tested by exposing buds to different levels of freezing temperatures and assessing the damage by the electrolyte leakage method.

In accordance with our first hypothesis we found the range of LT_{50}, i.e. the temperature at which 50% of maximum electrolyte leakage occurred, to be 9.4 K. The highest frost resistance was encountered in the Ukrainian provenance, in contrast to the most frost sensitive provenance from the Czech Republic with LT_{50} values of -28.7 °C and -19.3 °C, respectively. The results do not confirm the second hypothesis because the LT_{50} values were not correlated with winter minimum temperatures of the origins. We conclude from these results that the ecotypic differentiation of *F. sylvatica* does not reflect present-day climatic conditions. There are different possible reasons for this mismatch. Either frost hardiness is phylogeographically conserved and reflects different clades that evolved under different climatic conditions, or bud frost hardiness is not a key factor limiting the distribution of this species.

A3-O9: Host tree phenology affects epiphyte assemblages

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Species diversity in tropical rainforests is unmatched by any other terrestrial biome and has fascinated scientist for centuries. Among vascular plants in the tropics, epiphytes play a prominent role, locally comprising 10–50%. Current research tries to unravel the underlying mechanisms of their diversity, with a lively debate whether diversity is primarily affected by neutral or deterministic processes. In our study, we focus on the presumed deterministic effect of host tree phenology on the composition of epiphyte assemblages in the forest of Barro Colorado Island (BCI), Panama. This forest, characterized by a pronounced dry season of four months per year, features both deciduous and evergreen trees. During the dry seasons of 2010 and 2011 we conducted a quantitative study of epiphyte assemblages in large trees of five species on BCI. The two deciduous tree species we studied lose their leaves during this phase, thus we hypothesized that exposure to much higher radiation and increased evaporation in the leafless phase should affect epiphytes at different levels (community composition, size class distributions, physiology). Indeed, we found significantly lower epiphyte species richness on deciduous trees (*P. septenatum, C. platanifolia*) compared to evergreen (*A. excelsum*, *B. alicastrum*) and semi-deciduous (*C. pentrandra*) species, whereas the CAM-epiphytes' proportion in tree crowns was lowest in *A. excelsum* and *C. platanifolia*. This surprising finding for *C. platanifolia* is likely a sampling artefact. Very few species (≤3) were found per tree, of which at most one was CAM. As expected, we also found intraspecific variation: common epiphytes had significantly lower $\delta^{13}C$ values in *A. excelsum* than individuals in the other trees.

Variation among epiphyte assemblages on deciduous and evergreen trees at the intra- and interspecific level will be further analysed by growth measurements in 2012.

A3-O10: When things get tough you need spare tubes

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Halophytes comprise 1% of the world's flora. Within this group mangroves hold a special position as they are the only trees that grow in intertidal areas of tropical and subtropical regions. They are subjected to a combination of salt and flooding stress and on top, the strength of these stresses varies with time and space. Flooding level and duration depends on the lunar cycle and the position within the intertidal zone. The salt concentration of the soil depends on the time since the last flooding, and thus on the evaporation time, and the amount of fresh water input.

To deal with these harsh environmental conditions mangroves have developed several morphological and physiological adaptations, such as aerial roots, filtration of sea water at the root level and vivipary. But also the structure of the water transport system was found to be adapted to the special environmental conditions of the mangrove habitat.

We looked at xylem vessel characteristics from mangrove species of diverse families and from sites of contrasting salt and flooding stress levels. Redundancy was found to be the main characteristic of the hydraulic structure of mangroves. The higher the (variation in) soil water salinity the larger the conductive area of mangrove tree stems or branches. However, the hydraulic conductivity lowered with increasing conductive area.

A hydraulic system composed of many small conduits, is suggested to keep a basic hydraulic conductivity level even when a large proportion of tubes become inactive. Especially in the mangrove habitat, this strategy might be beneficial as trees are prone to drought-induced cavitation due to the low water potential of the salty water. The dynamic environment, with at least periods of drought and salt stress, seems be a strong driving force to keep vessel size small at all times. The advantage of small tubes might be the limited loss in conducting capacity when vessels embolize.

A3-O11: A root is a root is a root? - Plasticity of Citrus root orders under salinity

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Salinity is one of the most severe environmental factors limiting productivity worldwide. Knowledge about the plasticity of root system under salinity is scarce and especially lacking in regard to the hierarchical branching system of root systems, i.e. root orders, which are known to differ in function. Subsequently our study aims at quantifying the phenological plasticity and functional changes under salinity at root order level.

Four-year-old *Citrus* spp. trees were grown for six month under fresh water or high salinity (90 mM NaCl). The root system architecture, anatomy and morphology of root orders, as well as whole plant biomass allocation were compared. Sodium and chloride accumulation in leaves and roots were determined. Miniature depletion chambers were installed to compare the water flux densities among root orders under salinity and after short-term stress release.

Root traits known to influence uptake, e.g. frequency of root orders, specific root area, cortex thickness and xylem traits, did not change homogenously throughout the root system but were root-order specific. Sodium and chloride accumulations were related to the root order, with high salt concentrations in low root orders exceeding those in leaves. Water flux densities of first order roots decreased by >80% under salinity and did not recover under stress release. The water flux densities of higher root orders changed marginally under salinity and increased two to six-fold in second and third root orders under stress release.

While the total root system biomass was only slightly reduced, changes in the numbers of root orders and their frequency, morphology and anatomy indicate major modification of *Citrus* root systems under salinity. The root order-specific changes reflect the different vulnerability (as indicated by salt accumulation) of root orders but also indicate differences in the functional importance of root orders as evidenced by changes of water flux rates among root orders.

A3-O12: Silicon availability modifies the stoichiometry and contents of carbon compounds

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Silicon as non-essential element *in sensu strictu* for plant growth, nonetheless effects biotic stress resistance and may substitute carbon compounds in cell walls of grasses. Silicon availability changes during pedogenesis and is affected by plant silicon turnover. Recent studies revealed an interaction between silicon availability in a narrow range and nutrients as well as cellulose and lignin, shown for bulk analysis of the whole plants. We tested the effect of silicon availability in a broad range on the C : N : P ratio, content of carbon compounds and on aboveground biomass production of *Phragmites australis*. Our results show that individuals of *P. australis* grown under conditions of low silicon availability exhibit a different C : N : P ratio compared to plants grown under conditions of optimal silicon availability (maximum biomass).

In contrast to this, in plants grown under high silicon surplus the C : N : P ratio is similar to the treatment with low silicon availability. We found altered N : P ratios, whereas C : N ratios changed only slightly. Further, our results show that different levels of silicon supply changed the plant cellulose, lignin and phenol content depending on plant tissue function. Cellulose content in tissues with stabilization function is reduced contrasting enhanced cellulose content in tissues with photosynthesis function. Furthermore, higher silicon surplus decreased the phenol content in photosynthetic active tissues and increased the phenol content in culm. Only weak silicon to lignin interaction was found. These findings point to the potential of silicon to alter the ecological stoichiometry of the main nutrients, carbon compounds and biomass production of grasses. Resulting from this, silicon may affect the biogeochemical cycles in ecosystems dominated by grasses or sedges in the course of litter decay.

A3-O13: Reconciling metabolic theory of ecology with observed variation

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The metabolic theory of ecology (MTE) links physiology with ecology, and successfully predicts many scaling relationships in varied ecosystems. MTE predicts that in self-thinning stands of plants the relationship between mean individual biomass and density follows a power law with a slope of -4/3. However, empirical observations are more variable. Cause and mechanisms of this variation are still unknown. We developed an individual-based model that includes three elements which might explain the variation: a general model of plant ontogenetic growth, different modes of local competition (symmetric vs. asymmetric), and different levels of resource limitation. The presented model is more mechanistic (realistic) and performed better than previous, phenomenological growth models. Slopes were significantly shallower if competition was size-symmetric. Resource limitation affects more on intercepts but slopes. We conclude that on sites where size-symmetric competition prevails, ecological interactions can override predictions of MST whereas if asymmetric competition prevails, surviving plants are barely affected by interactions and therefore individual-level metabolic processes correctly predict population-level trajectories.

A3-O14: Heteroblasty in Bromeliaceae

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The term heteroblasty describes an abrupt change in form in the ontogeny of a plant. In contrast, homoblastic plants show no or only slight changes. Heteroblastic changes can be found in a number of plant families (e.g. Mimosaceae, Araceae); within the Bromeliaceae they are best-known among many members of the subfamily Tillandsioideae. Here, two major morphs can be distinguished, an early, atmospheric form, with narrow, lanceolate leaves with abundant absorbing scales, and a tank form with broad, overlapping leaf bases which store water. Our current understanding of heteroblasty suffers from a number of problems, not least from the fact that there is no quantitative definition to distinguish heteroblastic from homoblastic species. Moreover, before we can successfully investigate the ecological relevance of heteroblastic ontogenetic trajectories, lack of data on species occurrence and in situ growth makes functional interpretations difficult. Thus, we first had to develop a quantitative definition of heteroblasty and to collect demographic data in the field. We propose the use of the leaf index and successfully applied this method on 21 epiphytic bromeliads. Almost all species of *Vriesea*, *Guzmania* and *Catopsis* proved to be heteroblastic, while almost all studied *Tillandsia*s were homoblastic. In a few cases, we found changes in habit which are not reflected in sudden changes in index data. The additional third morph was dubbed gutta form. The early form in heteroblastic species lasts for only 10% of the life of an individual. Analyzing data from > 1000 individual bromeliads of 14 species covering their entire size range indicates that the transition from early to late form occurs after 2-4 years, while the biggest plants reach 12-40 years. Together with morphological and physiological data, we are now in a position to investigate the functional consequences and ecological relevance of the conspicuous ontogenetic changes in heteroblastic bromeliads.

A3-O15: The influence of environmental conditions on the sex ratio of *Antennaria dioica*

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The sexes in many dioecious plant species respond differently to specific environmental factors for there are two types of reproduction biology in male and female individuals. If seed production is successful, females invest a larger amount of resources in sexual reproduction and thus react to stress more sensitively. Several studies indicated that the sex ratio in stressful habitats is male dominated. We focussed on *Antennaria dioica* Gaertner, an endangered dry grassland species whose occurrence in Germany decreased rapidly in the last fifty years. We collected data on demography, reproductive fitness, and soil nutrients to examine if the amount of females decreases with increasing environmental stress factors like elevation, competition and nutrient deficiency. Additionally, we investigated if the fitness of sexes responds differently over a set of environmental conditions. We were able to demonstrate that the amount of females is positively correlated with increasing soil pH, decreasing soil conductivity and nitrogen content. Compared to males the fitness of females responds more negatively to increasing elevation and less negatively to competition. In general the sex ratio in the sampled populations is female - biased and the fitness of females is higher. These results contradict the expectations mentioned above partially. Other studies on *A. dioica* pointed out, that females get a greater mychorrizial benefit than males. Further the reproductive effort is not as high as expected, for only a few of the sampled populations produced fertile seeds. Increased stress susceptibility in females is therefore not a general rule. Further investigations should concentrate on sex ratio and germination requirements of the produced seeds.

Certainly, this strong biased sex ratio may counteract sexual reproduction, genetic diversity and persistence of the species.

A3-O16: Pollination biology and natural hybridization between *Verbascum densiflorum* Be

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Verbascum densiflorum Bertol. ("dense-flowered mullein") and *Verbascum nigrum* L. ("dark mullein") are the most abundant *Verbascum* species in Germany. Despite their abundance, no studies of their breeding system and pollination ecology have so far been attempted.

In this project, controlled pollination experiments were conducted to quantify the degree of selfing versus out-crossing in *V. densiflorum* and in *V. nigrum*. Furthermore, it was tried to investigate reproductive barriers between the two *Verbascum* species and natural hybridization was studied in an area of immediate contact of their populations, where the hybrid *V. adulterinum* W.D. J. Koch could be found.

The contribution of selfing in the reproduction of both species seems to be negligible, as all self-pollinated flowers failed to set seed.

Tests of the compatibility of interspecific crosses between *V. densiflorum* with *V. nigrum* revealed a high interspecific cross-compatibility. Pollination experiments verified F1-sterility of *V. adulterinum* as an effective postmating barrier between the parental species.

Additionally, premating reproductive barriers such as temporal displacement of flowering peaks, ethological isolation and partial habitat barriers are discussed in regard to their influence on the successful hybridization between *V. densiflorum* and *V. nigrum*.

Poster Presentations

A3-P1: Development of spring oilseed rape grown in different CO_2 exposure systems

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In order to investigate responses of crops to future atmospheric carbon dioxide (CO_2) concentrations, two experiments were conducted on spring oilseed rape (*Brassica napus* cv. Campino) within the framework of the integrated DFG-project on "Regional Climate Change" (PAK 346). A Mini-FACE (free-air CO_2 enrichment) facility and a climate chamber system at the Universität Hohenheim (Stuttgart, Germany) were used to expose plants to CO_2 enrichment.

Plant development in both experiments was examined from leaf emergence until crop maturity and compared concerning the effects of future CO_2 concentrations on oilseed rape. In the Mini-FACE system, plant height did not significantly differ between the treatments. In the climate chamber system, the canopy height was significantly increased under CO_2 enrichment at the beginning of the vegetative phase (P=0.049) and remained slightly increased (P≤0.1) during pod development. The leaf area index (LAI) in both experiments did not show any significant CO_2 effects. In the Mini-FACE system, LAI reached highest values at the stage of full flowering and declined during growth of pods. In the climate chambers, LAI showed fluctuations at the beginning of plant growth, which might have been affected by the pot and chamber design. Only a slight increase was observed at the stage of inflorescence emergence (P=0.084). The chlorophyll content of the youngest leaves in the Mini-FACE experiment was increased by elevated CO_2 at leaf development (P=0.027). At the end of flowering, SPAD values tended to decrease by 5.2% under elevated CO_2 (P=0.057). In the climate chamber experiment, a significant CO_2 effect on chlorophyll contents in youngest leaves was limited to the beginning of the vegetative phase (P=0.027). In both experiments, phenological development was not affected due to elevated CO_2.

A3-P2: CO_2 effects on amino acids in oilseed rape phloem and performance of aphids

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Global climate change is related to an increase in the concentration of atmospheric carbon dioxide (CO_2). Research on alterations in the nutritional quality of phloem sap in oilseed rape (OSR, *Brassica napus* cv. Campino) and dependent growth characteristics of phloem–feeding insects, such as green peach aphid (*Myzus persicae* Sulz.) under CO_2 enrichment, has not yet been performed. The aim of this study was to analyse the effects of elevated CO_2 on the concentration and composition of amino acids in the phloem sap of OSR and the resulting effects on the relative growth rate (RGR) of *M. persicae*.

A pot experiment was conducted in six climate chambers with two levels of CO_2 (ambient, 400 ppm and elevated, 600 ppm) at 22 ± 1-2^{o} C with an 18:6 h light:dark cycle and weekly rotations between chambers in order to avoid placement effects. Rape plants were infested with aphids at the development stage of the unfolding of the fourth leaf (BBCH 14). Samples of phloem sap were collected both before and 48 days after aphid infestation (BBCH 30). The exudates were analysed with HPLC in order to identify CO_2-induced impacts on the composition of amino acids.

Results showed that RGR of *M. persicae* was significantly decreased by 12.5% under elevated CO_2. Moreover, aphid RGR was significantly correlated to tyrosine (p = 0.024) and lysine (p = 0.010) under ambient CO_2 (BBCH 14), and tyrosine (p = 0.043), tryptophan (p = 0.048), phenylalanine (p = 0.047) and leucine (p = 0.040) under elevated CO_2 at stem elongation stage (BBCH 30).

In summary, elevated CO_2 alters the concentration of amino acids in the phloem sap of OSR, resulting in a worse performance of green peach aphids.

A3-P3: Diel dynamics of carbon isotopic fractionation during dark respiration

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Recently, increasing information on diurnal variation in the isotopic composition of dark-respired CO_2 ($\delta^{13}C_{res}$) has been gained in leaves, stems, and roots of several plant species, as well as in ecosystem respiration. The origin of enriched $\delta^{13}C_{res}$, which may increase by >10‰ above the putative respiratory substrate $\delta^{13}C$ along the day, is an ongoing matter of debate.

We present a species comparison of spatio-temporal variations of dark-respired $\delta^{13}CO_2$ and its putative substrate (water-soluble organic matter, WSOM) of leaves and roots along the plant axis and over the diurnal course. Pronounced spatial differences in $\delta^{13}C_{res}$ (up to 10.2‰) between topmost leaves and root tips were found. This indicates important organ-specific differences in post-photosynthetic fractionation during respiration. Additionally, a species-specific diurnal enrichment of leaf $\delta^{13}C_{res}$ above WSOM up to 15.9‰ was found. The amount of diurnal $\delta^{13}C_{res}$ enrichment was highly correlated (R^2=0.98) with the difference in $\delta^{13}C_{WSOM}$ between leaves and roots. In contrast to foliage respiration none of the investigated species displayed a distinct diurnal pattern in $\delta^{13}C_{res}$ of roots. These results indicate that the post-photosynthetic fractionation on the leaf-level, visible in diurnal $\delta^{13}C$ enrichment of dark respired CO_2, has a direct link to the well-known ^{13}C-depletion of leaves compared to heterotrophic plant tissues.

A3-P4: Daily stem growth patterns in five temperate broad-leaved tree species

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Radial growth in woody plants is principally controlled by the amount of carbohydrates supplied to the stem cambium and the duration of cambial activity, while it is regulated mainly by the water status of the cambial meristems and by hormonal control. Studies that use tree ring widths as an indicator of growth rate provide a mean value for annual conditions but lack the detail of seasonal changes in the rates of cambial activity over the year. This has the consequence that climatic variables identified as growth-controlling factors in dendrochronological analyses are not necessarily those factors that determine instantaneous rates of cambial activity. In contrast, high-resolution measurements of stem radial variation provide insights into diurnal cycles of stem water relations and they may allow studying the weather response of stem growth. This study uses electronic point dendrometers to examine the influence of environmental variables on the daily radial growth rate of five temperate broad-leaved tree species in the Hainich National Park in Germany. We focused on the effect of air humidity (RH) on radial growth because soil moisture is generally assumed to be the key determinant of the plant's water balance neglecting that water flows along the soil-to-atmosphere potential gradient with flux controlled by edaphic and atmospheric water status. Daily stem growth was extracted from diurnal cycles of stem radius changes as the difference between two subsequent daily maxima of stem radii. Daily growth increased linearly with RH and RH was identified as the single most important factor influencing daily stem growth in all species. We assume that RH changes during a day and between consecutive days influence tree water status on a daily time scale, while rainfall and resulting soil moisture variation exhibit a more coarse-grained event structure which often is of only secondary importance for the actual tree water status and thus for cambial activity.

A3-P5: Desiccation tolerance of tropical bryophytes

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Bryophytes are an important component of tropical forests. Climate change scenarios predict a temperature rise of 2 – 3 °C in this century, which may directly affect carbon balance due to an increase in nocturnal respiratory losses. The notion that this could force bryophytes uphill and cause their complete disappearance from lowlands is currently studied in our group. Here, we focus on another aspect of bryophyte physiology, desiccation tolerance. Climate change may alter precipitation patterns, and prolonged rainless periods may exclude species with limited tolerance. Experiments, in which we measure temporal variation in photosynthetic yield (Fv/Fm), allow us to quantify the effect of desiccation on bryophyte performance.

Eight Panamanian species from two different altitudes (sea level and 500m) are currently being dried out over the course of 3 months. A possible influence of life form on desiccation tolerance is taken into account by including mats, turfs and pendant species. Temperature conditions are close to natural. The influence of a possibly lowered relative humidity in the future is studied by different air humidity levels (30%, 60% and 90%). Fv/Fm of dark-adapted samples is measured, first directly after rewetting, then after 20min, 2h and 48h. Fv/Fm of controls, which are wetted frequently, is also measured.

First results suggest that desiccation tolerance is rather high in montane rain forest species. For example, Fv/Fm of the pendent species *Fulfordianthus pterobryoides* fully recovers in 24h after one month in the dry state. However, substantially longer drought (3 mo), results in visual damage like brown branches and Fv/Fm < 0.15 in all studied montane species.

In conclusion, tropical bryophytes seem to be well adapted to desiccation, which makes it unlikely that their tolerance is tested by moderate increases in drought periods in tropical forests in the future.

A3-P6: Epiphyte germination: From in vitro to in situ

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Vascular epiphytes are a prominent component of tropical ecosystems, but our understanding of their physiology is still quite limited. Most studies have focused on physiological responses to important abiotic factors in adults or juveniles, while the dependency of germination on ambient conditions have received little attention. However, germination is generally considered one of the most vulnerable stages in the life cycle of plants and may thus be a crucial bottleneck determining vertical community composition locally or species turn-over regionally. We are currently developing a standard experimental protocol for the study of germination (G) with the goal to examine a large number of species under similar conditions. To make sure that these experiments do not lack ecological realism, we conducted a number of trials analyzing the effect of different factors on experimental results. The following questions were asked: 1) How does seed maturity influence G? 2) Is light quality affecting G? 3) Do the effects of oscillating and constant temperatures on G differ? 4) Is there an interaction of the effects of temperature and water supply on G? 5) Is the duration of dry periods during G more important than the frequencies of wet-and-dry cycles? The results obtained to date indicate a high tolerance to intermittent water supply during G, in particular in species naturally found at exposed growing sites. Some tolerate extended drought during G, although G is generally impacted by drought. The response to drought varying in length correlates well with that to media differing in osmotic potential. The effect of increasing drought on G is not affected by temperature. There is no clear difference in G under constant or fluctuating temperatures, and light quality does not seem to affect G in epiphytic bromeliads either, many of which germinate even in darkness. This indicates that a "simple" protocol with constant temperature yields relevant results.

A4 Molecular population genetics: from patterns to processes and functions

Oral Presentations

A4-O1: Fragmentation affects genetic diversity of a high-altitude Polylepis forest

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The ongoing fragmentation of Polylepis forests in the tropical Andes may have severe consequences on the species' population genetics. We assessed the effects of altitude, historical and recent forest fragmentation on genetic diversity and structure of the wind-pollinated tropical treeline species *Polylepis incana* in central Ecuador. Genetic diversity estimated by the percentage of polymorphic bands (P) and Nei's expected heterozygosity (He) of adult trees was compared to that of seedlings in nine forest stands located along an altitudinal gradient between 3500 and 4100 m asl. In addition, genetic differentiation was analyzed using AMOVA, Φ_{ST}– statistics, and Bayesian cluster analysis. Genetic diversity at the population level was significantly lower in seedlings than in adults and, in both cases, negatively correlated to altitude. Genetic differentiation of the seedlings was approximately as high (Φ_{ST} = 0.298) as that of the adults (Φ_{ST} = 0.307), and geographical differentiation was clearly reflected in both AFLP profiles. Mountain ridges were found to act as genetic barriers to gene flow. Our study highlights the detrimental effects of unexpectedly strong genetic isolation, both recent and historical, despite the fact that the species is wind-pollinated and that distances between forest stands were comparatively low. We propose that in habitats with pronounced high-mountain landscape structures, gene flow may be hampered, even in wind-pollinated tree populations, resulting in species in such environments being relatively more sensitive to habitat fragmentation.

A4-O2: How does altitude and land use shape genetic variation in grassland plant species?

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Plant species in the Alps experience steep environmental gradients over relatively short geographic distances. The centre-periphery hypothesis posits that populations at the upper periphery are genetically more depleted and differentiated compared to populations at the range centre, as a function of population size and isolation. We tested this hypothesis in three grassland species with contrasting reproductive ecology, and examined the implications of altitude and land use, for population genetic parameters.

Using AFLP-markers we quantified genetic diversity, differentiation, and inbreeding within populations and spatial relatedness between individuals in *Briza media*, *Trifolium montanum* and *Ranunculus bulbosus*, three species with contrasting pollination mode from semi-natural grasslands, at 1200 and 1800 m a.s.l. on predominantly grazed or mown sites.

Genetic diversity was not affected by altitude. In *B. media* and *T. montanum* genetic differentiation among populations and relatedness among individuals within populations was higher at upper peripheral populations but did not differ in *R. bulbosus*. Only *B. media* exhibited elevated inbreeding at higher altitudes. Genetic diversity, differentiation and relatedness among individuals showed contrasting responses to land use depending on species.

Our study indicates that both altitude and land use are important in shaping the patterns of genetic diversity and differentiation. The interaction between these two variables might be synergistic in determining population genetic parameters. We discuss possible implications of these results for the conservation of semi-natural grasslands.

A4-O3: Assessing optimal successional stages for montane forest herbs with AFLP markers

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Using molecular fingerprinting we explored the potential of small-scale population analysis for understanding colonisation patterns of herb layer species in forests after canopy disturbance. We investigated clone sizes and the clonal structure of two common forest understorey species with different life forms (*Trientalis europaea* and *Calamagrostis villosa*) in the Harz Mountains in Germany in three different gap age classes (< 15 yrs, 15-60 yrs and > 60 yrs) and undisturbed forest. We hypothesized that clone sizes depend on age since gap formation and that clone size and ramet density are positively related.

Largest clone sizes of *T. europaea* were encountered in gaps of intermediate successional age (15-60 yrs), whereas clone sizes of *C. villosa* were found to be independent from gap age. Additionally, there was a positive relationship between clone size and ramet density for both species. Genetic variation was higher within populations of *T. europaea* and *C. villosa* than among populations. Furthermore, *T. europaea* was the only species with a clear genetic isolation by distance, pointing at an equilibrium between gene flow and genetic drift.

In conclusion, we showed that forest canopy gap dynamics clearly affect the small-scale structure of populations of understorey plants. Species with high lateral growth rates, such as *T. europaea* offer the possibility to serve as "ecological clock" for dating ecological processes.

A4-O4: Genetic diversity and fitness in endangered *Antennaria dioica* populations

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Increasing habitat fragmentation and decreasing population sizes are known to reduce plant fitness due to loss of genetic diversity. Consequently, genetic analyses are a powerful tool in conservation biology to understand the causes of decreasing sizes and numbers of populations in endangered species. *Antennaria dioica* Gaertner (Asteraceae) is a rare hemicryptophytic species in Central Germany. Population sizes of *A. dioica* decreased very rapidly in the last fifty years due to land use changes. Thus *Antennaria dioica* represents a useful key species to investigate the influence of management changes on species composition**.** We analysed 32 populations of *A. dioica*, using 168 polymorphic AFLP-markers to focus on three questions: 1. Do small populations of *Antennaria dioica* exhibit reduced genetic diversity? 2. Can we detect a correlation between genetic and geographical distances? 3. Are fitness parameters affected by decrease of genetic diversity? Data will be analysed using linear models to determine relationships among population size and genetic diversity and a Mantel test to explore correlations between geographic vs. genetic distances. Further, we will conduct a PCoA to investigate the genetic structure of the populations and an AMOVA to calculate genetic differentiation between and within populations. We are going to discuss the results with respect to the rapid decline of this species and potential consequences for its management.

A4-O5: Genetic diversity and extent of hybridization of invasive *Ulmus pumila*

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Invasive populations often develop from only a few introduced individuals and therefore are subjected to genetic drift, bottlenecks and founder effects. However, the extent of these influences depends on the breeding system, and consequences for genetic structure are also influenced by the potential occurrence of hybridization with native species in the new range.

Ulmus pumila is a native of temperate regions of East Asia, and occurs westwards up to the dry Gobi desert, where it is bound to water surplus sites and oases. Introduced as fast growing windbreak or shady tree, the Siberian elm naturalized and is now considered as noxious or invasive in Argentina and 46 states of the United States. Previous works of Zalapa et al. (2009 and 2010) revealed that genetic diversity levels of *U. pumila* populations in Wisconsin and parts of the Midwest are comparable to the native range; the studies also showed a high extent of hybridization with *U. rubra*.

Our project focuses on invasive populations of *U. pumila* in Argentina and six states of the Western United States where no *U. rubra* populations occur. We used microsatellite markers to compare the genetic diversity between these invasive populations and populations from the native range. Furthermore, we compared the genotypes of our samples with genotypes of known pure *U. pumila* and *U. rubra* samples to test for hybrids in the sampled regions. Results will be discussed regarding the importance of genetic diversity and the influence of hybridization to the invasion success of *U. pumila*.

A4-O6: Molecular genetic evidence for clonal stands of *Quercus pubescens*

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Quercus pubescens Willd. is widespread at low and middle altitudes throughout Southern Europe. In Central Europe the species is restricted to disjunct, climatically favourable sites. Several square meter sized, domelike clusters of up to 4 m high oak stems or clusters of dense thickets of stunted growth, are scattered on shallow soils in the large seminatural dry grasslands of C and S Italy.

These patterns of stem emergence strongly suggest clonal growth within clusters. In fact, to the best of our knowledge, clonal growth has never been reported for *Q. pubescens* so far. To test the hypothesis that the observed clusters of stems represent single clones we investigated their population genetic structure using molecular markers. Clusters were located in two highland areas of S and C Italy. Individual stems were tagged and mature leaf tissue was collected for 11 clusters and in sum 135 stems, ensuring inclusion of all potential groupings, i.e. tree-like individuals, shrub-like individuals and combinations thereof. DNA was extracted from leaf samples and amplified by PCR using 16 polymorphic microsatellite loci (simple sequence repeats, SSR) from *Q. petraea*. Allele frequencies were identified for each locus and subjected to population statistical analyses. Results on genetic differentiation patterns among sampled stems within clusters on Monte Gargano show identical genetic structure suggesting that they were generated by clonal growth. Field observations confirm the capability of clonal growth by resprouting from the base of the trunk as well as by sprouts from roots.

This knowledge has implications for the persistence of *Q. pubescens* populations across a long time-span of climatic fluctuations (i.e. the last glacial cycle) as well as for their future development in a changing climate.

A4-O7: Phylogeography of a late successional subtropical tree species indicates range stability

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The modern distribution of plant populations is determined not only by the current environment, but also by past events like pleistocene climate cycles. Although subtropical China is proposed not to be covered by a large ice sheet during the Last Glacial Maximum, the dramatic climate fluctuations might have affected species distributions. However, only for few species in this region the phylogeography has been investigated. In this study, we used sequences of two non-coding cpDNA fragments and nuclear microsatellites loci to investigate the spatial genetic structure of *Castanopsis eyrei*, a dominant tree in subtropical evergreen broad leaved forests in China. Thirty-one populations with total 614 individuals were analysed. At microsatellites, high levels of genetic diversity in the total population (H_T=0.88) and within populations (mean H_S=0.80) were observed. Population differentiation (standardized F'_{ST}= 0.443) was pronounced. Bayesian analysis of population structure with STRUCTURE revealed two most likely clusters, which largely correspond to the Western and Eastern part of the distribution range. The Eastern cluster harboured significantly higher genetic diversity (A_R, p=0.036) and lower differentiation (F'_{ST}, p<0.001) than the Western. Significant isolation by distance was found both overall and within Western and Eastern clusters. At chloroplast DNA, sixteen distinct haplotypes were identified. Eight haplotypes were restricted to a single population, mostly in the Western cluster. A “star-like” network was constructed showing many closely related haplotypes. Population differentiation was substantial as revealed by high values of both G_{ST} (0.709). Western populations exhibited greater differentiation and population diversity than Eastern populations. We did not find any significant patterns of isolation by distance for cpDNA indicating a predominant role of genetic drift. Thus, genetic drift dominants the genetic patterns, especially cpDNA pattern, which could be attributed to more limited seed dispersal compared to pollen dispersal. Overall our study suggests long term stability of the range rather than climate driven range shifts.

A4-O8: Genetic structure of peripheral and central populations of *Carduus defloratus*

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One of the most important issues in biogeography is to understand species' range limits. It has been suggested that because of less suitable conditions peripheral populations are smaller, less dense, more isolated and produce less seeds than central populations. As a consequence they should exhibit lower genetic diversity and greater genetic differentiation than central populations. We compared population characteristics and individual reproduction as well as genetic diversity and genetic differentiation of populations of the perennial, insect-pollinated rock plant *Carduus defloratus* (Asteraceae) along a gradient from the centre to the margin of its distribution in Central Europe.

As expected, peripheral populations were smaller, less dense and produced less viable seeds than central populations. Amplified fragment length polymorphism analysis indicated that genetic diversity was lower in peripheral than in central populations. The genetic distance between peripheral was higher than between central populations. The pairwise genetic distance between populations increased with their geographic distance. There was significant genetic differentiation between the two types of populations, but variation among populations within types was higher, and most of the genetic variation was among individuals within populations. In *C. defloratus*, the range limit may be influenced by the reduced reproductive success of peripheral populations. Seed abortion was higher in peripheral than in central population and increased with decreasing genetic diversity, indicating early inbreeding depression.

A4-O9: Landscape effects on gene flow between populations of an endangered damselfly

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Habitats of many damselfly species (Odonata, Zygoptera) have become fragmented and various connectivity measures are being implemented to enhance dispersal of individuals and gene flow among remnant populations. Such strategies, however, should be based on knowledge of species-specific dispersal characteristics and the identification of landscape elements impeding or facilitating gene flow. Here, we studied dispersal in the endangered damselfly species, *Coenagrion mercuriale*, inhabiting ditches in an intensively managed agricultural landscape in the Swiss plateau. In an area of 120km^2, all 15 known populations were genetically analysed with 12 microsatellite markers. Bayesian spatial clustering methods were used to detect genetic groups. Individual group assignment probabilities were then interpolated to the entire study area and overlain on a landcover map. In addition, between all pairs of populations, straight line corridors of different widths were drawn and the proportions of several landscape elements in these corridors were calculated (e.g. area of forest, settlements or roads). We tested the influence of these landscape elements on gene flow, measured as pairwise genetic differentiation (F_{ST}), using multiple regression analysis on distance matrices. Results of the spatial clustering analysis showed a northern and a southern genetic group, whose boundaries coincided with a continuous hill ridge intersecting the study area. The ridge also dissects above ground watercourses between the two groups. Regression analysis showed that geographic distance and cumulative height change acted as barriers, whereas open agricultural land slightly enhanced gene flow. Areas of settlements, roads and forests did not correlate with genetic differentiation. Findings of this study will provide information for further planning of conservation strategies for *C. mercuriale* in Switzerland.

A4-O10: River engineering determines gene flow of threatened Gravel Grasshopper

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Habitat loss, its fragmentation and restriction in gene flow triggered by landscape modification are main topics in conservation biology. In the majority of rivers in Central Europe hydro power stations, reservoirs and bank reinforcements modify natural river dynamics intensively. Hydropeaks and reduction in floodplain areas minimize habitat connectivity of riparian species and constitute a threat to them. In the present study we examined the impact of five drainage water treatments and three reservoirs on the population genetics of the critically endangered Gravel Grasshopper *Chorthippus pullus*. Twenty-two populations were sampled at the river Isar in Germany and 752 individuals genotyped with seven specific microsatellites. Bayesian population genetic analysis showed three genetic clusters at the regional scale and gene flow corresponded to water flow direction in the main river. At the local scale and in two tributaries gene flow was not directed. Contrary to expectation, isolation by distance was not detected and reservoirs had no impact on the gene flow among subpopulations above and below them. These results can be explained by the significant impact of the drainage water treatments on allelic richness and gene diversity of the regional grasshopper population. We suggest that the former drought of river stretches over decades enabled connectivity of subpopulations and high grasshopper abundance. Thus, the impact of migration barriers is not detectable today. Conservation of this critically endangered species seems to be compatible with water management and river engineering provided that habitat connectivity and population density are sufficient.

A4-O11: Resampling reveals geneflow in a flightless ground beetle species

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While sampling of populations can show the occurrence of secondary clines, resampling allows estimation of the intensity of ongoing gene flow as if gene flow is not interrupted, a secondary cline is expected to decline. We analyzed the genotypes at the diallelic Est-1 locus of 977 individuals of *Carabus auronitens* collected during 2005-2006 from 29 sites located in the Westphalian Lowlands (northwestern Germany). We compared the allozyme gradient to that found in individuals collected from the same populations during 1985-1994. While both data sets showed clinal variations, pairwise analysis shows a significant decrease in the steepness of the cline. We believe that the beetles use the hedgerows which are common across the fragmented landscape as migration corridors as *C. auronitens* is a flightless ground beetle. The average gene flow is estimated to be 0.6% of each population per generation.

A4-O12: Global warming triggers loss of genetic diversity of *Z. exulans* populations in European high mountain systems

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Climatic oscillations of the past have strongly shaped the genetic differentiation of cold adapted species. Recent (and predicted) climatic changes pose a thread for these species, as their occurrence is determined both by the genetic constitution as well as physiological tolerance. In order to assess the threat of a cold-adapted species under global warming conditions, we combined genetic approaches (allozymes, fluctuating asymmetry) with a species distribution modelling to evaluate both future loss of populations (or distribution range, respectively) and presence of unique genetic variability under different climatic scenarios.
In total 24 populations from the Pyrenees, the Alps, the Apennines and the Carpathians were examined. Populations from the Alps show highest genetic diversity, while the Apennines population is genetically impoverished. Genetic stress is indicated by high levels of fluctuating asymmetry, which were negatively correlated with heterozygosity levels. Based on climatic projections, future global warming will trigger a further reduction of genetic diversity, and several populations, partly with unique genetic variability, might become extinct.

Poster Presentations

A4-P1: The effects of inbreeding and outbreeding in the endangered *Silene chlorantha*

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By crossing plants from different depleted populations genetic diversity can be enhanced leading to a better plant performance (heterosis). However, in case of adaptation to the local environment inter-population crosses can also have negative effects on plant performance (outbreeding depression). To investigate the consequences of between-population gene flow, we conducted a pollination experiment between 5 different sized, geographically isolated, and genetically variable populations in the self-compatible endangered dry grassland perennial *Silene chlorantha*. Different cross treatments were performed: 1. between different levels of genetic diversity (selfing, outcrossing between depleted populations, outcrossing between depleted and diverse populations), 2. geographic distance (<1 km, 1-20 km, 20-100 km), and 3. population size (<150 individuals, >150 individuals). For the F_1 progeny, we analysed genetic diversity (AFLP) and plant performance in a common garden experiment. The genetic diversity of crosses between depleted populations could not be increased. Genetic diversity could only be enhanced if one partner originated from a genetically diverse population. Progeny of outbreeding from genetically diverse populations featured significantly higher genetic diversities than inbreeding ones. Significant inbreeding depression concerning plant size was found in offspring of self-pollinations in depleted populations. Progeny of crosses between genetically diverse and large populations featured an increased plant performance. Progeny of crosses between geographically distant populations had increased plant size. The results of this study are discussed in the context of local adaptation, reinforcements, and promotion of gene flow among small and isolated populations for optimised conservation strategies.^

A4-P2: Phylogeography of the European Larch using mtDNA sequence variation

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Studies of past climate changes are crucial for predicting the impact of the ongoing human-induced climate change on forest ecosystems. Genetic data combined with palaeoecological data can be used in simulation models to estimate future distribution of tree species under climate change. This study deals with European Larch (*Larix decidua*), which is of special interest because of its important role in the plains of north-central Europe during the last ice age, which is indicated by fossil records for range shifts. *L. decidua* occurs in montane to subalpine regions in Europe, for example in the Alps, the Tatra Mountains and the Sudety Mountains. An exception are the populations in central Poland, which are often considered as a different subspecies (*L. decidua* ssp. *polonica*) and occur in the polish lowlands. The study is using mitochondrial DNA (mtDNA) markers which are maternally inherited in members of the Pinaceae family and show a higher fixation than parentally or biparentally inherited DNA. Due to this the markers are well suited to identify different haplotypes, colonization routes and ice age refugia.

In a first step, six mtDNA-regions were sequenced by transferring universal primers or primers from other conifer species. Next, a subset of eight samples from all over the distribution range was analysed to identify intraspecific variation within these regions. Polymorphic mtDNA regions were used as genetic markers to study geographic patterns of mtDNA-haplotypes on a larger set of samples.

The obtained sequence data were used for phylogenetic analyses among haplotypes. Using haplotypic data, measures of genetic diversity were estimated as well as population structure. Furthermore, the data set was checked for phylogeographic structure among populations.

First results will be presented and discussed against the background of the postglacial history of *L. decidua* and other forest tree species.

A4-P3: Low genetic differentiation in invasive *Rosa rugosa* populations in dune habitats

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Rosa rugosa Thunb. (Rosaceae) is native to East Asia where it colonises estuary dunes and shingle beaches. It also forms dominant stands in coastal regions of NW Germany and is considered here as a problematic invasive shrub. Studies from Denmark suggest a lower genetic differentiation of introduced populations compared with native populations (Kelager 2009). As genetic analyses are missing for populations of the German North Sea coast we characterised the genetic structure of *R. rugosa* populations in dune habitats of the Frisian Islands with DNA-genotyping (RAPD/PCR-technique). UPGMA cluster analysis revealed a low genetic differentiation between all populations analysed. *Rosa rugosa* cultivars obtained from regional nurseries were closely related to *R. rugosa* genotypes collected in the dune habitats. Neither the sampled dune populations nor the cultivars were clearly clustered. An additionally conducted PCoA (principal coordinate analysis) showed a neighbouring location for the individuals from the same Frisian Island. We included spiderplots and 95% confidence ellipses on the PCoA that match categories defined by the individuals from the same Frisian Island. Tere, the results verified a clear separation for some of the islands (e.g. Amrum vs. Wangerooge), whereas other island populations are placed in between categories or overlap.

A4-P4: Effects of topography and climate on population genetics of Aeonium species

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The genus Aeonium Webb & Berthel. is one of the most popular examples for adaptive radiation on islands within the plant kingdom. In a relatively short evolutionary period various ecological niches have been realized and a great variety of morphological forms and ecophysiological characteristics has developed. The Canary islands are the clear centre of species diversity within that genus and recent research results imply a phylogenetic origin on that archipelago, stating Aeonium as neoendemic. Most of the species occur only on single islands and clear intrageneric lineages with vicariant island distributions can be seen, which, with respect to the young geological age of some of the Canary islands, indicates recent speciation and ongoing evolutionary processes. Considering phylogenetic and biogeographical relationships we selected three single island endemic Aeonium species of Tenerife, El Hierro and in particular La Palma and one variety distributed across two islands to identify population structures, potential evolutionary relevant differentiations and gene flow barriers with regard to island topographies and the various climatic habitat factors on these islands. From each taxon DNA-samples comprehensively have been taken throughout the entire distribution ranges respectively. Intraspecific genetic variabilities are detected by ISSR-fingerprintings (Inter Simple Sequence Repeats) and by population genetic analyses, GIS studies and incorporation of climate data we aim to detect geographically or ecologically conditioned population differentiations. Beside these biogeographical and evolutionary investigations we combine the genetic population structure data with regional climate models and future habitat suitability models to recognize potential impacts of climate change on the investigated Aeonium taxa and thus the recent and future endangerment status of these spatially strongly restricted species.

B1 Biogeochemistry: Coupling of above- and belowground ecosystem processes

Oral Presentations

B1-O1: Carbon isotope fluxes in the plant-soil-atmosphere continuum

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The flux of carbon dioxide between the terrestrial biosphere and the atmosphere is approx. 15-20 times larger than the anthropogenic release of CO_2. This large bidirectional biogenic CO_2 flux has a significant imprint on the carbon isotope ratio of atmospheric CO_2, which in turn helps to understand the controls of CO_2 fluxes and to predict how they will respond to global change. However, there is still a lack of understanding of the fate of newly assimilated C allocated within plants and to the soil, stored within ecosystems and lost to the atmosphere. Stable carbon isotope studies can give novel insights into these issues. Here, a general scheme of the flow of C from the atmosphere through plants and soil will be depicted from initial fixation during photosynthesis, allocation within plants, its way into the soil both via root exudation and litter production, turnover during soil organic matter formation, and, finally, return to the atmosphere as carbon dioxide through plant and soil respiration. Isotopic fractionation processes along the plant-soil-atmosphere C pathways will be described and assessed with respect to their usefulness as markers for plant responses to changing environmental conditions. From the presented evidence it can be concluded that there exists a tight coupling of physical, chemical and biological processes involved in C cycling and C isotope fluxes in the plant-soil-atmosphere system. Generally, research using information from C isotopes allows an integrated view of the different processes involved. However, complex interactions among the range of processes complicate or impede the interpretation of isotopic signals in CO_2 or organic compounds at the plant and ecosystem level, creating the need for new research approaches.

B1-O2: Rapid C flow through the plant-soil system in differently managed grasslands

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In terrestrial ecosystems plant-soil interactions are of key importance for short-term carbon (C) cycling because plants transfer a substantial part of recently assimilated C to their roots and rhizosphere soil biota. Changes in grassland management can induce changes in C cycling via shifts in composition, abundance or activity of plants and/or soil biota. In this study we investigated whether grassland management practices for plant diversity restoration influences short-term rates of C assimilation and transfer from plants to soil microbes. Thereto we performed an in situ 13C-CO2 pulse-labelling study in a long-term plant diversity grassland restoration experiment to trace the C uptake by different plant species and the transfer of the plant-derived 13C to key groups of soil microbiota. We found marked differences between different plant taxa in the rate of 13C assimilation and concentration: uptake was greatest and 13C concentration declined fastest in *Ranunculus repens*, and assimilation was least and 13C signature remained longest in mosses. Recent plant-derived 13C was quickly incorporated in microbial phosopholipid fatty acid (PLFA) markers, as we found them most enriched 24h after labelling. The greatest incorporation of 13C was in the PLFA 16:1ω5, a marker for arbuscular mycorrhizal fungi (AMF), while after 1 week most 13C was retained in the PLFA18:2ω6,9 which is indicative of assimilation of plant-derived 13C by saprophytic fungi. Our results of 13C assimilation by plants and its transfer to soil microbes were not altered by the grassland restoration management treatments. Our findings suggest that plant diversity restoration management may not directly affect the C assimilation by individual plant taxa or groups of soil microbes, but can impact on the fate of recent C by changing the abundances of plant and soil taxa. Moreover, across all treatments we did find particular rapid transfer of plant-derived C to AMF and decomposer fungi, indicating their consistent key role in the cycling of recent plant derived C.

B1-O3: Tracing effects of drought on the plant-soil C transfer in a mountain meadow

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Mountain regions are characterized by a pronounced vulnerability to disturbances. Especially ecosystem structure and functioning show a large potential to be affected by global change, for climate warming is taking place at higher rates in the Alps than observed in most other parts of Europe. More intense and frequent extreme weather events such as droughts, heat waves and heavy precipitation events are predicted in the near future, which will likely affect biogeochemical cycles. To detect impacts of an extreme summer drought event on the carbon (C) cycle we installed rain-out shelter on a mountain meadow in the Tyrolean Alps during growing season in 2010. After 8 weeks of drought we simulated a heavy precipitation event by adding a high amount of previously collected rainwater. Droughted and control plots were labelled with $^{13}CO_2$ to trace the way of C from atmosphere over plants to soil and soil microbes. The uptake of ^{13}C into aboveground biomass was slightly lower under dry conditions; however significantly less ^{13}C was found in the belowground biomass of droughted plots. These results will be further discussed with regard to compound-specific analysis of plant carbohydrates. Microbial biomass decreased during drought and incorporated less recent C, but actual enzyme activity increased. In consequence, dissolved organic C (DOC) accumulated in the top soil, which had a higher proportion of recent C as compared to controls. Rewetting of droughted plots caused a rapid decrease of DOC and its $\delta^{13}C$, and an immediate increase of microbial biomass. The investigation of phospholipid fatty acids extracted from soil will provide further insight into soil microbial community dynamics and ^{13}C incorporation of microbial taxa. We conclude that drought has distinct effects on various components and processes in the plant-soil system, thereby altering short-term C dynamics in mountain grasslands.

B1-O4: δ13CO2 reflects post-drought rewetting effects on ecosystem carbon dynamics

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A transient increase in soil CO_2-efflux after rewetting of previously dry soils, termed Birch effect, can significantly influence the ecosystem C-balance. This has been related to increased soil microbial respiration in response to a temporal increase in labile soil carbon. However, hypotheses on effects of rewetting on the soil microbial community range from beneficial (e.g. increased substrate supply for mineralization) to harmful (e.g. hypo-osmotic stress and cell lysis) and a mechanistic understanding is still lacking. We monitored rewetting effects on soil and ecosystem C-fluxes and their isotopic compositions ($\delta^{13}C$) during and after summer drought in a Mediterranean oak woodland. After rewetting $\delta^{13}C$ of soil respiration showed strong enrichment (-18‰) and a rapid return to initial values (-27‰). This transient enrichment

was smaller after severe drought in August (ca. -22‰) and was best explained by a hypo-osmotic stress response of the soil microbial community to sudden moisture changes. After first natural rains, $\delta^{13}C$ of both soil and ecosystem respiration were well correlated on both diurnal and fortnight scales. Soil respiration contributed up to 95% to ecosystem respiration after rewetting. Further, variations in $\delta^{13}C$of soil respiration explained ~71% of the variability in isotopic composition of ecosystem respiration. In contrast to irrigation experiments, the increases in soil and ecosystem respiration were not transient and peaked three days after the initial precipitation pulse, which might be explained by delayed rain infiltration resulting in only gradual changes of soil water potentials. The speed of moisture change might control the microbial answer to rewetting and thus the origin of the Birch effect. Quantifying the effect of soil rewetting on ecosystem carbon balance is of major importance, particularly in perspective of increasing droughts and rainfall variability in semi-arid and arid systems, which can be expected from climate change.

B1-O5: Ecology of truffles: stable isotopes in studying host-mycorrhiza relationships

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Under natural conditions most plant species are benefitting from the symbiosis with mycorrhizal fungi. A considerable part of soil nutrients and water is taken up by and pass through the mycorrhiza hyphae, which in return benefit from the carbohydrates supplied by the host plants. Some mycorrhizal fruit bodies, like *Tuber aestivum*, have also a peculiar gastronomic value and many attempts for its profitable cultivation have been undertaken in Mediterranean areas. However, many issues of truffle ecology are poorly understood, in particular optimal conditions favouring fruit formation, potential host plants and host-mycorrhiza relationships. In this study we tested the applicability of stable isotope measurements under natural abundance to identify plants which may host the mycorrhiza of *Tuber aestivum* and to characterize host-mycorrhizal nutrient, water and carbohydrate exchange, both in situ and under controlled laboratory conditions. For these purposes, sampling of the fruit bodies of *Tuber aestivum* was performed during the growing season 2010 in a mixed broadleaved-coniferous forest in central Italy. δ13C, δ15N and δ18O were analysed in the fungal material, in the soil where the fungi bodies were collected and in the plant material of the potential host species (xylem water in the trunk, braches and leaves, recently assimilated carbohydrates in phloem and leaves). Productivity of *Tuber aestivum* under contrasting light regimes was also assessed. Impact of the mycorrhizal presence on plant metabolism was additionally studied under controlled laboratory conditions on a number of host tree species. The results showed a possibility of the identification of the mycorrhizal host species applying isotope analyses, with mycorrhiza receiving most part of the carbohydrates from the conifers in our site. Fractionation steps during the 15N and H218O uptake and upward transport and 13C assimilation and its downward translocation were identified. In respect to the truffles response to different light levels a conclusion on the suitable forest thinning regimes for the yield optimisation was driven.

B1-O6: Elevated CO_2 and warming at treeline: more carbon losses than fixation?

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Warmer temperatures, changes in extreme events and elevated atmospheric CO_2 concentrations will probably affect plants and ecosystems at treeline.

In a unique treeline experiment, we enhanced CO_2 concentrations and temperatures at plots with 35-year-old larch and pine trees. We studied growth, freezing sensitivity and carbon balance.

We found that enhanced atmospheric CO_2 and warmer temperatures enhanced growth of some species at treeline. Better growing conditions, on the other hand, led to higher sensitivity to extreme events such as freezing. Warming enhanced loss of recalcitrant carbon.

Our results indicate that future plant growth at treeline will probably be enhanced, but extreme events may offset some effects of climate change. However, due to carbon losses from the soil, no considerable carbon sink may be expected in the short term.

B1-O7: Sink or source? Carbon dynamics in soil and vegetation of riparian forests

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Riparian forests are known to store huge amounts of organic carbon in soil and vegetation. At the same time, floodplain ecosystems are strongly altered by human activities such as dike construction which may transform these ecosystems from net carbon sinks into carbon sources. We studied historic carbon dynamics in river sediments and forest biomass in Donau-Auen Nationalpark, Austria. 98 trees of four important species were sampled for dendrochronologic and dendrogeomorphologic analysis along a lateral gradient from the Danube main channel at both sides of the Marchfeld dike. Tree age and depth of the stem base below ground were used to estimate historic carbon sedimentation rate. Based on radial increment and allometric equations, we calculated carbon accumulation in vegetation per year. Organic carbon sedimentation rates significantly decreased with greater distance from the main river channel. Moreover, annual carbon sedimentation rates of soil in inactive floodplain areas were significant lower than in active floodplain forests. In contrast, annual carbon sequestration of vegetation was not influenced by the Marchfeld dike. Our study highlights the role of active floodplains with existing river dynamics for below-ground carbon accumulation. Areas with pronounced flood dynamic are characterized by a particularly high carbon increment per year. In addition, dike construction proved to reduce allochthonous carbon input through sedimentation. We conclude that river engineering and restoration measures should be re-evaluated considering possible influences on carbon sequestration.

B1-O8: Bryophytes attenuate anthropogenic nitrogen inputs in boreal forests

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Productivity in boreal ecosystems is primarily limited by available soil nitrogen (N), and there is substantial interest in understanding whether deposition of anthropogenically derived reactive nitrogen (N_r) results in greater N availability to woody vegetation, which could result in greater carbon (C) sequestration. One factor that may limit the acquisition of N_r by woody plants is the presence of bryophyte carpets, which are a significant C and N pool, and a location where associative cyanobacterial N-fixation occurs. Using a replicated stand-scale N-addition experiment in the boreal zone of northern Sweden, we tested the hypothesis that sequestration of N_r into bryophyte tissues, and down-regulation of N-fixation would attenuate N_r inputs, and thereby limit anthropogenic N_r acquisition by woody plants. Our data showed that these two mechanisms accounted for 56.7% of cumulative N_r additions at the lowest N_r addition rate, but only a minor fraction for all other treatments. This “bryophyte effect” in part explained why soil inorganic N concentrations, net N mineralization rates, and N acquisition by shrubs and trees (indicated by their $\delta^{15}N$ signatures) remained unchanged up to N addition rates of 12 kg $ha^{-1}yr^{-1}$ or greater. Finally, we demonstrate that approximately 71.8% of the boreal forest experiences N_r deposition rates at or below 3 kg $ha^{-1}yr^{-1}$, suggesting that bryophytes likely limit woody plant acquisition of ambient anthropogenic N_r inputs throughout a majority of the boreal forest.

Poster Presentations

B1-P1: CO_2 concentrations in tree stems: a balance between soil and tree respiration

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Stem respiration is an important component of the terrestrial carbon cycle, as it contributes 25 to 50% to the total above-ground carbon budget. However, there is still no consensus about abiotic and biotic variables that influence the processes involved. Recent studies provide evidence that the CO_2 stem efflux that is usually measured by chambers attached to the stem surface, is not representing the true stem respiration, but is highly influenced by internal CO_2 fluxes. Internal CO_2 fluxes could serve as an explanation for the high variability of previously reported stem efflux rates and temperature uncoupling, however the relation of the internal fluxes to the stem efflux is still unclear.

In this study, continuous stem CO_2 concentrations ([CO_2]) were examined in a subalpine Norway spruce forest on various time scales over two years. Daily mean [CO_2] was most closely related to daily mean stem temperature and cambial activity of the trees, but depending in its magnitude on the tree physiological period within an annual cycle. The daily course of [CO_2] was best explained by the translocation of root-respired CO_2 with the xylem water. Accordingly, a tight relation to soil efflux was found, confirming a close coupling of tree physiological and soil-related processes via transpiration. The relation of [CO_2] and soil efflux was best described by an exponential fit, whereas soil temperature and stem temperature were linearly related. Thus, soil efflux and [CO_2] obviously exhibited different temperature responses: Soil efflux increased exponentially with temperature, whereas [CO_2] got saturated at higher temperatures, most likely due to stomata closure under high temperatures, leading to a breakdown of transpiration and translocation of CO_2.

B1-P2: Tracing carbon allocation into above- and belowground pools and fluxes

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An integrated understanding of the soil-plant continuum and reciprocal feedbacks between photosynthetic C fixation, above- and belowground respiration and carbon allocation into different plant organs is of major importance. It is well known that different plant organs have distinct carbon isotope signatures ($\delta^{13}C$, e.g. 1‰ to 6‰ difference between leaves and roots in our experimental plant *Halimium halimifolium*), which was shown to be reflected in post-photosynthetic fractionation effects on foliage respiration. The extent of this phenomenon depended on species and environmental conditions. We hypothesized that this can be explained by different carbon allocation strategies.

Three treatments were used to induce shifts in carbon allocation in *H. halimifolium*: control, nutrient limitation (higher investment in roots), and light limitation (higher investment in leaves). We used a soil/canopy chamber system that enables independent measurements of above- and belowground $\delta^{13}CO_2$-exchange. This allowed us to calculate the carbon gain during photosynthesis and the carbon loss during respiration on a whole plant level. The carbon allocation to different plant organs and their $\delta^{13}C$ values were analyzed over one year. Furthermore, detailed short-term allocation pattern of recently fixed carbon were investigated in a $^{13}CO_2$ pulse labelling experiment, revealing a rapid carbon transfer to the roots, where assimilated ^{13}C was detected in soil-respired CO_2 after 4.5 hours. The results give valuable new information on the coupling of different above- and belowground carbon allocation strategies and the $\delta^{13}C$-pattern of plant material and respiration.

B1-P3: Impacts of a rain-pulse on short-term dynamics of evapotranspiration and δ18OET

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Evapotranspiration (ET) is an important component of the continental water cycle. Thus, a precise estimation and partitioning of the component fluxes is essential. The use of stable isotopes is a common method for partitioning whole ecosystem ET. Only recently, the availability of water vapour isotope laser spectrometers in combination with soil gas exchange chambers enables measurements of $\delta^{18}O_E$ and $\delta^{18}O_{ET}$ in high frequencies. Although $\delta^{18}O_E$ is widely used in partitioning approaches, little is known about variations in $\delta^{18}O_E$ due to fast changes in soil water content and water isotopic profiles in the soil as expected from rain pulses and subsequent dry-down periods. We conducted a rain pulse experiment under controlled conditions to evaluate the influence of rapid changes in the soil water balance on different vegetation components. *Plantago lanceolata* was planted in 50L pots and grown for 6 weeks until a canopy cover of up to 100% was reached. To evaluate the influence of roots and mycorrhiza on the soil water balance, we used four different treatments – bare soil (root and mycorrhiza free); soil with mycorrhiza; soil with ingrowing roots and mycorrhiza; fully developed *P. lanceolata* canopy. All pots were separated in inner and outer compartments, inserting root and mycorrhiza selective meshes. Under well watered conditions, soil evaporation (E) contributed to ET by 27%. After the water pulse the contribution of E rose up to 70%. With the subsequent decrease in soil water content over the following 6 days the contribution of E declined to 40%. Directly after a rain pulse $^{18}O_E$ and $^{18}O_{ET}$ showed a strong diurnal increase of up to 4‰ and 2‰, respectively. This diurnal variability decreased until stable values were reached 3 days after the rain pulse. Further, the presence of roots and mycorrhiza in non-vegetated plots significantly reduced soil evaporation, probably due to much higher soil moisture contents and slower dry down in bare soil plots.

B1-P4: Use of stable isotopes for mechanistic insights in ecosystem carbon partitioning

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Partitioning ecosystem respiration into its components can provide a large contribution towards a more process-based understanding of ecosystem carbon dynamics and their climatic drivers. We used a high-time resolved mass balance approach combining both respiration fluxes and $\delta^{13}C$ to partition the respiratory carbon fluxes of a Mediterranean ecosystem into all major component fluxes during a spring to summer transition period. The approach showed the potential to successfully separate soil and ecosystem carbon fluxes into their autotrophic and heterotrophic components, providing the possibility to directly access different responses in isotopic carbon fluxes to changes in abiotic drivers. Further, combining a straight-forward Intube-incubation approach with chamber-based keeling plots enabled high-time resolved measurements of respiratory $\delta^{13}C$ of all major ecosystem components. We found large short-term variations in isotopic composition of CO_2 respired ($\delta^{13}C_{res}$) from foliage and roots in response to decreasing water availability at both diurnal and fortnight time scales. While foliage respiration exhibited enrichment during day (up to 6‰) and a subsequent depletion during night, $\delta^{13}C_{res}$ of roots exhibited an opposite pattern with increasing enrichment at nighttime (up to 5.5‰). This effect became more pronounced with increasing drought. These findings are in accordance with recent theories on post-photosynthetic fractionation in the dark respiratory pathways and during phloem loading. So far the Keeling plot method is the only way to determine isotopic composition of ecosystem respiration ($\delta^{13}C_R$). However, small CO_2 gradients owing to low respiratory activity or strong vertical mixing often impede the calculation of significant keeling plot regressions. Our results indicate the approach as an alternative bottom-up tool to estimate $\delta^{13}C_R$ during times when sufficient CO_2 gradients for keeling plots are difficult to capture.

B1-P5: Carbon sequestration in the ecosystem Hamburg- Methods and first results

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Cities cover only a small portion of the world's surface, but harbour more than half of its population. Despite the large number of urban dwellers, cities as ecosystems just recently came into focus of scientists with special attention being paid to urban ecosystem functions and services.

One of the services urban ecosystems offer is the sequestration of carbon. Studies focusing on urban carbon sequestration are scarce and mainly deal with carbon bound in urban forests in the US. Although it is unlikely for a city to sequester its entire CO_2 emission, it has been shown that the urban vegetation stores a significant amount of carbon and plays an important role in the carbon cycle.

Since most of the studies about urban carbon sequestration have been carried out in the US, a similar study for Europe would be of interest. The vegetation of Hamburg is regularly mapped in detail and the gathered information is integrated into a GIS-based vegetation map. In this study, the city area of Hamburg will be stratified using this map. Each stratum will be tested for its carbon content by 1) measuring woody biomass and 2) testing the carbon content of the upper soil layers in ten sample plots for each stratum. Woody biomass will be measured by gathering information about species, thickness and height of all trees within the sample plots. Soil carbon content will be measured by pooling different soil samples of the uppermost 10 and 30 cm within each sample plot and subsequent analysis.

By calculating the average carbon content of each stratum and the surface covered by it, it will be possible to calculate the amount of carbon stored in the vegetation and soils of Hamburg.

B1-P6 A toy model for the dynamics of N limitation under enhanced CO_2

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How does the nitrogen dynamics in the plant-soil system respond to a large increase of atmospheric CO_2? From an experimental point of view this is studied in FACE (Free Air CO_2 enrichment) experiments. Here this question is followed from an abstract theoretical point of view by setting up and analyzing a simple conceptual model. The model consists of two coupled ordinary differential equations for organic and mineral nitrogen. Analyzing the response of this system to a step increase in atmospheric CO_2, four different cases of possible dynamical behaviour with respect to nitrogen limitation can be distinguished. Two of them go along with progressive nitrogen limitation (PNL). It turns out that a decrease in soil mineral nitrogen cannot be used as an indicator of PNL, as is sometimes assumed in the literature. These results are discussed in the light of experimental studies of nitrogen limitation under increased CO_2.

B1-P7: The development of the retrogressive phase in a long term chronosequence

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Volcanoes in south central Chile are the most actives in South America with significant eruptions documented since mid-Pleistocene, until recently, in year 2009, creating a landscaped of different age lava formations. They vary from very deep old soils, characterized by several horizons of ash depositions, to recent basaltic scoria that reset soil development. Therefore, based on different stages in pedogenesis, and applying the principle of "space for time substitution" a long term chronosequence was reconstructed. The questions of this work were; along the established long term soil chronosequence: 1) is it evident a retrogressive phase in tree basal area and species diversity linked to a retrogressive phase of carbon and limiting and essential nutrients in soils? 2) how do patterns of limiting elements in soils relate to patterns in leaves of dominant species, how do they differ in evergreens vs. deciduous? 3) is the pattern of soil carbon related to microbial activity of heterotrophic nitrogen transformations in soils? Results showed that basal area reached a maximum at about 3470 years BP of soil age followed by a humped trajectory and a strong decrease in tree species diversity in the oldest substrate age, which is characteristic of long term chronosequences associated to a retrogressive phase in the substrate. The standing decrease in contents of total carbon, nitrogen, total and available phosphorus and base cations, beginning at ca. 3470 years

BP, evidenced a retrogressive phase which may be linked to the documented decrease in the humus binding non-crystalline minerals during pedogenesis in volcanic soils. The strong retention of available forms of nitrogen in volcanic soils would allow its increase over time. In leaves tissue it translated in a decrease in N use efficiency and the maintenance of N:P ratio over time at the ecosystem level, however with striking differences among evergreen and deciduous species. Project Fondecyt 1090135

B2 Emerging topics in ecosystem research: winter climate change and ecosystem functioning

Oral Presentations

B2-O1: Snow cover and plant phenology: using a network of automated snow sensors

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Alpine shrub- and grasslands are shaped by extreme climatic conditions such as a long-lasting snow cover and a short vegetation period. Such ecosystems are expected to be highly sensitive to global environmental change. Prolonged growing seasons and shifts in temperature and precipitation are likely to affect plant phenology and growth. In a unique experiment, climatology and plant growth was monitored for almost a decade at 17 snow meteorological stations in different alpine regions along the Swiss Alps. Regression analyses revealed highly significant correlations between mean air temperature in May/June and snow melt out, onset of plant growth, and plant height. These correlations were used to project plant growth phenology for future climate conditions based on the gridded output of a set of regional climate models runs. Melt out and onset of growth were projected to occur on average 17 days earlier by the end of the century than in the control period from 1971–2000 under the future climate conditions of the low resolution climate model ensemble. Plant height and biomass production were expected to increase by 77% and 45%, respectively. The earlier melt out and onset of growth will probably cause a considerable shift towards higher growing plants and thus increased biomass. Our results represent the first quantitative and spatially explicit estimates of climate change impacts on future growing season length and the respective productivity of alpine plant communities in the Swiss Alps.

B2-O2: Responses of boreal dwarf shrubs to changing snow conditions

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Snow is known to have a major impact on vegetation in arctic and alpine ecosystems, but little is known about the role of snow in boreal forests where snowpack is uneven because of tree canopy. The responses of the evergreen *Vaccinium vitis-idaea* and the deciduous *V. myrtillus* to changing snow conditions were studied in a coniferous in southern Finland. The following manipulations were carried out: 1) partial removal of snow; 2) addition of snow; 3) compression of snow; 4) formation of an artificial ice layer. The manipulations were maintained through the winter and the ecophysiological and phenological responses were recorded. Additionally, the diurnal course of leaf CO_2 exchange in *V. vitis-idaea* was estimated at the time of maximum snow depth in late March.

Even if partial removal and compression of snow increased the occurrence of freezing temperatures, no differences were observed in the electrolyte leakage of the leaves or shoot tips. However, decreased Fv/Fm ratios of chlorophyll fluorescence in the leaves of *V. vitis-idaea* indicated increased stress on the partial removal plots. The leaves of *V. vitis-idaea* retained their photosynthetic activity under snow. In late winter, net gain of CO_2 was achieved at noon on all the manipulations excluding snow addition. When integrated over the whole day, the subnivean photosynthesis compensated for a substantial proportion (15-80%) of the respiratory CO_2 losses. The timing of phenological events in *V. myrtillus* showed small but significant differences among the treatments. Bud burst occurred two days earlier on the addition plots than on the partial removal plots. Comparable differences were observed in the timing of leaf unfolding and flowering. No changes were observed in the phenology of *V. vitis-idaea*. In conclusion, the present study shows that both the thickness and physical properties of snow affect the overwintering success, the photosynthetic activity and, to lesser extent, the phenology of *Vaccinium* species.

B2-O3: Winter N availability and freezing interact to reduce biomass in *Poa pratensis*

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Winter warming can alter plant cold acclimation and frost exposure by decreasing snow depth, increasing the frequency of midwinter thaws and altering the frequency and intensity of soil freeze thaw cycles (FTC). FTC can increase plant N availability over winter, but it is unclear if winter N uptake increases summer plant productivity. Alternatively, root frost damage can also reduce productivity. We assessed the interactive effects of increased winter N availability and increased frost damage on biomass production in the grass *Poa pratensis*. We potted tillers in sand and kept them in a common garden prior to winter N addition and freezing treatments. Freezing was administered at - 11°C in an incubator during winter thaw periods (December and February), and freezing treatments were crossed factorially with N addition (0.75g/m^2 in December, January and February). Tillers were frozen either prior or after receiving N over winter. Non frozen plans with winter N addition increased in aboveground biomass by 44% compared to controls. The biomass of plants frozen in February with no prior N addition was reduced by 28% relative to controls, but surprisingly was 85% greater than plants frozen in February that had received prior N additions. Biomass was lowest in plants that were frozen twice, and N addition had no effect on the biomass of plants frozen prior to N addition in December. Our results suggest that winter N availability can be beneficial or detrimental to summer plant growth. In the absence of extreme frost events, increased winter N availability can enhance summer plant growth. On the other hand, increased N availability may hasten deacclimation and make plants more susceptible to frost. Freeze injury can also prevent N uptake over the rest of winter. Overall, the net benefit or detriment of increased winter warming is likely to depend on the timing of frost events relative to winter N availability.

B2-O4: Effects of artificial-snow on vegetation: a case study at Monte Bondone/North Italy

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Snow reliability is the basic requirement for a successful winter sport resort. All recently reported scenarios of future climate in the Alps show that the zero-degree limit will rise by about 300 – 500 meters in altitude. Considering this development, the intensification of artificial snow making appears unavoidable and its effects on vegetation will get more important. Despite this trend, studies about the long-term effects of artificial snow-making are rare. The aim of this study was to determine the effects of ski piste up-grading (machine grading and artificial snow production) on vegetation at species- and ecosystem-level at the ski resort of Monte Bondone (Trento) in the Southern Alps. Our work was based on technical documentations, vegetation and soil maps from the years 1991 and 2008, field visits and about 154 vegetation assessments according to the method of Braun-Blanquet (1946) in the years 1991, 2006, and 2008. The comparison of the average number of species of a non-snowed Nardetum alpigenum with one snowed for 16 years showed a decrease of 9 species. The use of artificial snow also caused a change of relative proportions of functional groups. The longer artificial snow was applied, the larger was the proportion of woody-plants and the lower the number of spring time flowers like e.g. *Primula vulgaris* and *Crocus albiflorus*. Moreover, the dominance of some species shifted. For instance *Festuca rubra* replaced the typical *Nardus stricta* of traditional alpine meadows because of its larger moisture tolerance. Due to more intensive winter sport activities, the ever-growing demands on ski areas by tourists and the predicted climate change, artificial snow production will be even more important (some might say essential) in the future. It will therefore become even harder to balance economical needs and conservation demands in alpine regions.

B2-O5: Importance of soil temperature variation during the snowmelt period in eutrophic mountain plant communities in Southern Norway

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The aim of this study was to analyse differences in soil temperatures between and within exposed ridges, leesides, and snowbeds during one year. The study was performed in two mountain areas, north- and south of the Hardangervidda mountain plateau (Norway). Data loggers recorded soil temperatures twice daily, in 60 study plots, stratified to eutrophic vegetation. In each plot, species abundances were estimated in percentage ground cover, and snowmelt was monitored. TWINSPAN classification was used to separate small-scale vegetation groups. The relationship between these small-scale vegetation groups and soil temperature conditions was tested by Detrended Correspondence Analysis, Principal Component Analysis, and Canonical Variates Analysis. Soil temperature parameters (mean and standard deviation) were estimated for each small-scale group, and for exposed ridges, leesides, and snowbeds as general main groups. The results demonstrate that the annual

variation in soil temperatures differed significantly, not only between exposed ridges, leesides, and snowbeds, but also between the small-scale vegetation groups. Plant species composition seemed to be highly correlated with soil temperatures. To distinguish between small-scale vegetation groups, soil temperature conditions during the snowmelt period were most important, followed by growing season- and winter soil temperature conditions. Soil temperatures during autumn were not significant. The winter half-year is also predicted to be most affected by future climate change in Norwegian mountains.

B2-O6: The moving soil -impact from cryoturbation upon arctic plant communities

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Non-sorted circles (NSCs)—also known as frost boils—are patterned ground features that create a small-scale mosaic of vegetation zones in many periglacial landscapes. Yet the mechanisms causing the plant community structures and soil chemistry to vary within NSCs are debated. In this study, we investigated species diversity and aboveground biomass of plant communities (vascular plants, moss and lichen) together with soil nitrogen contents from the sparsely vegetated centre of the circles to the densely vegetated outer NSCs. In addition, we related them to the estimated surface soil age within NSCs gradients along with the distance from the centre of NSCs. Soil ages were inferred using lichenometry and 210Pb dating. The repeated mass-movement of surface soil caused the continuously increasing soil age from the centre towards the outer side of NSCs. Depending on the distances from the centre of NSCs, species richness, species diversity, aboveground biomass and soil nitrogen contents differed significantly. In the middle distance, species richness, species diversity and aboveground biomass were highest. Furthermore, highest content of soil nitrogen was investigated in the middle age of soil. We suggest that the observed spatial variation in plant community structures and soil nitrogen contents in the NSCs is driven by this small-scale variation of soil ages in additions to differences in micro-climatic conditions that were suggested in the previous studies. Based on our results, ceased activities as a result of the ongoing climate warming in the arctic are likely to reduce small-scale (1-3 m) variation of plant-soil system in tundra ecosystems.

B2-O7: Seasonal dynamics of soil CO_2 efflux under elevated atmospheric CO_2

Lisa Schottler[1], Claudia Kammann[1], Gerald Moser[1], Ludger Grünhage[1], Christoph Müller[1]

[1]Department of Plant Ecology, Justus-Liebig-University Giessen, Giessen, DE

The study of soil respiration, a significant component of biospheric CO_2 fluxes to the atmosphere (Schlesinger 1977; Raich and Potter 1995), and the response to elevated atmospheric CO_2 is of major interest for supporting efficient mitigation strategies to global change.

The study site was the Giessen FACE (Free Air Carbon dioxide Enrichment) experiment,

consisting of three CO_2 enrichment (E plots) and three ambient control rings (A plots). Since May 1998, carbon dioxide concentrations were elevated to +20% above ambient, all-year-round during daylight hours. The vegetation is a wet grassland (Arrhenatheretum elatioris Br.-Bl.).

Since 1998, we quantified ecosystem respiration under ambient and elevated CO_2 from vegetated plots. In June 2007, we introduced measurements of soil respiration from vegetation-free subplots using the Li-Cor 8100 system. In 2010, we added a preliminary study using transparent automated chambers for quantifying net carbon exchange (NCE).

Our results indicate a seasonal trend of CO_2 efflux. During winter dormancy, soil respiration rates were significantly higher under elevated CO_2, whereas during growing season in 2008 and 2009 there was no significant difference between the treatments regarding soil CO_2 efflux. In late summer-autumn and winter, ecosystem respiration was stimulated in the elevated CO_2 plots.

We suggest from our grassland study that, during growing season until harvest in autumn, additional CO_2 input is assimilated and stored by plants, while enhanced heterotrophic respiration is governing the altered winter CO_2 efflux.

B2-O8: Temperature and litter availability control C efflux from an alpine ecosystem

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In high latitude and altitude ecosystems, winter soil respiration contributes substantially to the annual CO_2 effluxes. Despite low air temperatures, soil microbes remain active under thick insulating snow packs, but carbon sources and processes involved, as well as the sensitivity to changing snow cover remain largely unknown.

To identify the sources of soil-respired CO_2 in winter, we added labelled litter (13C/15N) and measured its contribution to the CO_2 efflux and incorporation into microbial biomass. By removing the insulating snow cover, and thus lowering soil temperatures on half of the plots, we also investigated the response of these processes to changes in winter climate.

Litter addition increased CO_2 efflux by up to 30% at the beginning of the winter, but the added litter contributed less than 15% to the total C efflux. Colder temperatures reduced soil respiration, but not the proportion of litter respired. Respiration rates, their stimulation by litter addition and the proportion of C derived from added litter decreased over winter.

In summary, our results show that soil respiration in winter contributes significantly to annual CO_2 effluxes and that it is dominated by old C. Therefore, winter processes play an important role in the balance of soil organic matter.

Poster Presentations

B2-P1: Effects of winter warming pulses on soil faunal activity and primary production

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Effects of winter warming pulses on soil faunal activity and primary production in the temperate grassland and dwarf-shrub heath. Ongoing climate change is expected to increase the recurrence of soil freeze-thaw cycles (FTC) in cool-temperate and other high-latitude regions due to decreases in snow cover and increased variability of winter air temperatures. To investigate the ecological implications of altered FTC regimes we used a controlled field experiment at two sites differing in winter climate (lowland site: Ecological-Botanical Garden Bayreuth and upland site with more severe winter climate: Waldstein, Fichtelgebirge). Lysimeters containing six 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 and received winter warming pulses (IR-heaters) or ambient conditions in five replications per site. Soil faunal activity during winter was assessed by bait-lamina-sticks and soil enzymatic activity (Beta-Glycosidase, Cellobiohydrolase, Xylosidase, Chitinase, Phosphatase). Plant performance in the following growing season was characterized by Aboveground Net Primary Production (ANPP) and fine root length (via minirhizotrons). Statistical analysis of these datasets is ongoing and results will be presented. We hypothesized that warming pulses, which are accompanied by more frequent FTC, result in increased soil faunal activity and higher biomass production due to increased nutrient availability. The results are going to be discussed with respect to climate change and ecosystem functioning.

B2-P2: Absence of snow cover reduces understory plant cover and alters plant community

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Evidence is growing that altered snow regimes due to climate change can strongly affect biogeochemistry of cool-temperate to arctic ecosystems. The effects on plant communities, however, are largely unexplored despite their obvious influence on relevant processes.

Here, the impact of snow cover on understory community composition and below-ground production in a boreal *Picea abies* forest was investigated using a long-term (8-year) field-scale snow-cover manipulation experiment consisting of the three treatments: snow removal, increased insulation (Styrofoam pellets), and control (n = 3). The snow removal treatment caused longer (118 days versus 57 days) and deeper soil frost (mean minimum temperature -5.5°C versus -2.2°C) at 10 cm soil depth in comparison to control.

Understory species composition was strongly altered by the snow-cover manipulations, mainly because vegetation cover generally declined by more than 50% in the snow removal treatment. In particular, the dominant dwarf shrub *Vaccinium myrtillus* (-82%)-and the most abundant mosses *Pleurozium schreberi* (-74%) and *Dicranum scoparium* (-60%) declined strongly. C:N ratio in *V. myrtillus* leaves and plant available N in the soil indicated no nitrogen deficiency in. Fine-root biomass in summer, however, was negatively affected by the reduced snow cover (-50%), particularly in the upper 10 cm.

Observed effects are attributed to direct frost damage of roots and/ or shoots. Besides the obvious relevance of winter processes on plant ecology and distribution, we propose that shifts in the vegetation caused by frost damage to shoots and roots are responsible for a high proportion of the reported alterations in biogeochemistry in response to altered snow cover. Understory plant performance clearly needs to be considered to understand the biogeochemistry of boreal systems in the face of climate change.

B2-P3: Seasonal dynamics of soil CO_2 efflux under elevated atmospheric CO_2

Lisa Schottler[1], Claudia Kammann[1], Gerald Moser[1], Ludger Grünhage[1], Christoph Müller[1]

[1]Department of Plant Ecology, Justus Liebig University Giessen, Giessen, DE

The study of soil respiration, a significant component of biospheric CO_2 fluxes to the atmosphere (Schlesinger, 1977; Raich and Potter, 1995), and the response to elevated atmospheric CO_2 is of major interest for supporting efficient mitigation strategies to global change.

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We suggest from our grassland study that, during vegetation period until harvest in autumn, additional CO_2 input is assimilated by plants, while enhanced heterotrophic respiration is driving the altered winter CO_2 efflux.

B2-P4: Northern plants and climatic warming – modelling the ecophysiology of overwintering

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The environmental conditions of plants are projected to change globally during the coming decades due to climate change. The changes are predicted to be especially pronounced in the north during the winter. The change in climate will bring about novel combinations of environmental factors not experienced by contemporary plants. Experimental determination of the effect of various climate change scenarios on plants are often limited by the resources and effort needed to carry out multiple treatments. This shortcoming can, at least in part, be overcome by the use of ecophysiological process-based dynamic models. The successful use of dynamic models in climate change research requires that the models are properly tested and parameterised by experimental data. By modifying phenological dynamic models of the annual cycle of forest trees, we developed dynamic models for the overwintering of perennial field layer plants in the boreal zone with the purpose of identifying functional overwintering types that can be used when modelling the effects of climate change and especially changes in wintertime conditions. The models were parameterised by using data from a series of growth chamber experiments with plants representing different functional groups from dwarf shrubs, hemicryptophytes, overwintering rosette plants, and grasses. Our results show that there are differences among both plant species and functional groups in the timing of growth onset following for example warm periods in the winter. Several types of responses regarding timing of growth onset can be seen. Premature growth onset during winter affects plant hardiness, and may lead to tissue damage during subsequent cold periods. Differential responses among species may result in changes in species composition. Dynamic process-based models of the overwintering responses of plants can be incorporated in geographical models and thus used to refine predictions of the consequences of climate change on the vegetation.

B2-P5: Rising rate of plant diversity change on alpine summits in Switzerland

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[1]WSL Institute for Snow and Avalanche Research SLF, Davos, CH

Botanists with mountaineering skills climbed many high summits in the Alps already centuries ago to study the altitudinal limits of plant life. They assembled species lists of more than 250 Swiss alpine summits. Such data sets have been used as a basis for long-term biodiversity monitoring since the 1980ies (see time line at bottom for past researchers).
The snow line, i.e. the line below which the winter snow cover does not necessarily melt over summer, has been rising considerably since these historical records.

We revisited over 100 summits in the Swiss Alps that were botanized ~ 100 years ago, and some of them also between 1983 and 1993. This gives us the possibility to analyse the dynamics of diversity change over time, and in reference to the snow line.
On most summits, the species numbers increased more and at a higher rate (steeper curve) during the last decades than previously. The rate of species change tended to be higher on mountains with lower visitor frequencies.
The enrichment of the alpine summit flora is likely driven by climate warming, which has accelerated since the mid 1980ies. Other environmental factors, such as increased hiker numbers on these summits, can strongly modify the response of species numbers to climate change. It remains to be analysed in the coming months whether the species pool remained constant or changed in reference to the snow line.

B3 Wildfire effects on ecological functions, patterns and processes

Oral Presentations

B3-O1: Evaluation and projection of forest fire risk indices for the German states

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Forest fires are among the most common natural hazard to forest ecosystems. Over 10,000 ha have been lost to forest fires since 1993 in Germany with estimated losses over € 41 million. Fire risk is expected to increase in the light of climate change and global warming. Various meteorological forest fire risk indices have been developed to forecast the risk of fire occurrence and aid forest managers to take suitable preventive measures. In this study, we evaluate a six of the existing meteorological fire risk indices for their predictive capacity against recorded monthly fire numbers and burnt area from 1993-2009. Some of these indices have not applied before in a German context and no study exists on the performance of indices for all of Germany on a regional scale and on a monthly basis. Among the indices studied, the modified M-68, which is officially used in Germany for fire risk forecast and the Canadian Fire Weather Index (FWI), modified for European conditions, correlated best with observed fire data. Relative humidity is another factor which showed high correlation with monthly number of fires. The monthly distribution of fires over the year presents distinct spring and summer high fire periods.

Future fire risk (2031-2060) was projected using the modified M-68 for different temperature and moisture scenarios with weather data from the regional climate model, STAR, and compared against simulated fire risk from the reference period (1961-1990). The past fire scenario had only one extreme fire period in a year - during spring, while summer fire risk was only about half the spring fire risk. In contrast, the future projections show a considerable increase in summer fire risk that matches the present spring fire risk. Spring fire risk also increases by a small amount. The increase signifies possible extension of the fire period to February and November, which are presently not considered months of high fire risk.

B3-O2: Modelling burned area in Africa

Veiko Lehsten[2], *Peter Harmand*[1], Ilaria Palumbo[3], Almut Arneth[2]

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[3]Department of Geography, University of Leicester, Leicester, UK

We used a generalized linear model to predict the burned area in Africa from the explaining variables tree cover, herb cover, precipitation over the last dry season, wet season and averaged over the last 2 years, a fire-danger index (the Nesterov index), and the population density. Data are satellite data (MODIS MCD45A1 product) rescaled to 1 degree by 1 degree grid cells. The model correctly predicts the spatial distribution and the extent of fire prone areas though the total variability is underrepresented.

One reason for this work was the wish to combine the results with dynamic vegetation models and global climate models in order to predict possible changes in fire activity. An application of the model with simulated climate data ranging from 1980 to 2060 resulted in a strong decrease of burned area of ca. 20-25%.

Our original model ignored spatial autocorrelation, which is however partly compensated by very similar spatial dependencies in the dependent variable and the predictors. In the talk we also report on ongoing efforts to improve the model with more advanced techniques from spatial statistics.

B3-O3: Modelling pyrogenic gas emissions: effects of models vs. burned area estimates

Wolfgang Knorr[1], *Veiko Lehsten*[1], Hongxiao Jin[1], Almut Arneth[1]

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Biomass burning is one of the largest sources of atmospheric traces gases and aerosols globally. Emissions from biomass burning can be quantified by a combination of observed burned area, terrestrial ecosystem models to simulate fuel loads and the effect of fire on ecosystem dynamics, and emission factors that relate combusted biomass to the emission of various trace gases. However, different versions of global burned area data derived from satellite observations and emissions models still show major discrepancies. Studies on burned area products have so far focused on product inter-comparison, while the consequences of those discrepancies for fuel simulations and emissions modelling with ecosystem models are still unknown.

Here, we perform a sensitivity analysis of the influence of burned area products and emissions models using the ecosystem model LPJ-GUESS and modified version of the global fire model Spitfire. The emissions model follows two different strategies: a conventional one where fixed emission factors are multiplied by biomass combusted, and an alternative one where combustion efficiency depends on the ratio of grass to total combusted litter. Aerosol particle mass is also computed, following two different approaches derived.

B3-O4: Global fire modelling

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Fire is an important Earth System process, which impacts climate via multiple pathways, including atmospheric chemistry, aerosols, land surface properties and the carbon cycle. At the same time fires are controlled by climate and the frequency of fires is expected to increase with future climate change. As such fires form a complex feedback cycle in the Earth system which potentially forms an important contribution to the climate sensitivity of the Earth System. The net effect of fires on the climate system remains unclear as depending on the process fires can cool or warm the Earth System. Moreover the climate impact of single processes operates on different time scales ranging from days to centuries. A quantitative analysis of this contribution requires Earth System models that include the coupled climate-carbon cycle and take into account fire-climate interactions.

Here we will present work on the implementation of fires as a climate-dependent dynamic process into a coupled Earth System model. Fires are implemented as a disturbance process in the dynamical vegetation model JSBACH, which is the land component of the Max Planck Institute for Meteorology Earth System Model. We will introduce a metric to evaluate fire models on a global scale that combines different fire properties that are important for the fire-climate impact, such as spatial distribution, interannual variability, and the peak month of the fire season. We show results based on the burned area reported in the GFEDv3 dataset for the years 1997 to 2009. In general, the model underestimates burned area for Africa and tends to overestimate it for South America. Peak months of burning are for most regions reproduced by the model with a lag of +/- 1 month.

B3-O5: Environmental correlates of plant succession after fire in the Central Alps

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Rising temperatures and more frequent drought events will put European forests at fire risk. This raises the question of the resilience of forests that have been rarely or not at all touched by fire. To give answers for forests in the Central Alps, we monitored the re-colonisation of plant species after a stand-replacing fire set by arson during the heat wave of 2003 in the Valais, Switzerland. Along a 1300 m elevational gradient, 153 survey plots of 200 m² were systematically located in an area of 300 ha. From 2004 to 2007, both plant species coverage and tree species abundances were registered annually. We found a rapid rise of species richness during the first three years after the fire with a higher richness level towards the timberline. Species richness correlated negatively to edge distance and fire intensity. More species were hence found in proximity to untouched forests or open land. Tree regeneration was reduced in lowest elevations where Scots pine dominated before the burn. Patterns of transiently dominant species were conspicuous during the first four years after the fire, a rare phenomenon that relates to early successional stages in the species-rich environment of dry central Alpine valleys.

B3-O6: Post-fire regeneration in western Canadian boreal mixedwoods

Stefanie Gärtner[1,2], Mike Bokalo[2], Ken Stadt[2], Ellen Macdonald[2], Phil Comeau[2]

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Fire is the most important natural disturbance in the western boreal forest. Most mature boreal mixedwoods in Alberta today originated from fire. The proportion of natural forest remaining is declining rapidly. Therefore it was a unique opportunity that we had to study the post-fire regeneration of natural stands. Although a good deal of post-fire vegetation development research has been done, there is a lack of information showing how western boreal mixedwoods regenerate after fire.

The objective of our study was to conduct a broad survey using standard regeneration assessment protocols and evaluate regeneration attributes for fires 10 to 20 years after the fire disturbance.

The heterogeneity in stand structure within the different fires was also of interest as well as how well the late successional species *Picea glauca* was regenerating.

Five fires in central and northern Alberta within the Lower Foothills and the Central Mixedwoods ecological subregions were selected. We compared the effect that different pre-fire stand compositions had on post-fire regeneration. Stands within the fires were delineated into broad classes (pure conifer, conifer dominated, deciduous dominated and pure deciduous stands) based on pre-fire regional forest inventory maps. Within each stand we applied a systematic sampling design for collecting regeneration data. A total of 506 plots were sampled in 22 stands.

In all fires aged 10 - 13 years old the unstocked proportion of plots was 9% (D) and up to 43% (C). Overall, the mean conifer density was much lower (3,570 trees/ha) than the mean deciduous density (12,225 trees/ha). There was a high level of density heterogeneity in the regeneration between fires as well as between pre-fire cover types within each fire.

In terms of stocking and density, pre-fire deciduous stands showed the quickest recovery while trees in the mixedwoods were, on average, taller. In all cases the pre-fire conifer stands showed the least amount of regeneration potential.

B3-O7: Fire and ecosystem engineers: an island endemic pine ruling system dynamics

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Pine forests of the Canary Islands are prone to frequent fire. Over the last 30 years, fire frequency has increased by one power of magnitude. In response to fire (or to primeval herbivory), *Pinus canariensis* has evolutionarily developed a unique feature among all 112 pine species known: it is capable of resprouting extraordinary long needles from adventive buds in stems and branches, thus performing effective photosynthesis and fog drainage soon again after fire. Additionally, despite being a weak competitor, *Pinus canariensis* builds large mono-dominant stands between 900 - 1500 m a.s.l in the trade wind zone, even where previously more diverse laurel forests are supposed to have covered the slopes. Currently, these pine forests are believed to play a crucial role in balancing the water household of the island.

We propose, that *Pinus canariensis* is an “ecosystem engineer” positively interacting with fire for exclusion of competitors thereby shaping ecosystem functioning with respect to the hydrological cycle. For fueling our assumption, we here 1) report on the recent fire regime of the Canary Islands by using remote sensing techniques, 2) document the resprouting ability of *Pinus canariensis* along a fire history gradient showing own field data, and 3) discuss emerging interconnected issues in the fields of ecosystem engineers, fire ecology and ecosystem services.

B4 Biogeochemistry: linking ecosystem processes and function across scales

Oral Presentations

B4-O1: Effects of water availability on CO_2 and H_2O exchange in a ponderosa pine forest

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Ecosystem processes will be affected by changes in the hydrological cycle, significantly impacting the C balance of water-limited ecosystems. However, photosynthesis and respiration processes differ in their water-sensitivity and water-limitation, causing uncertainties in C balance estimates. Thus, to better understand water availability as driver of the C balance in a seasonal water-limited forest, we studied the coupling of component ecosystem CO_2 and H_2O fluxes in relation to soil water content (SWC) and atmospheric water deficit (VPD) under natural summer drought and well watered conditions (irrigation).

The CO_2 and H_2O fluxes generally decreased during natural summer drought. The response of ecosystem photosynthesis (Pn_{eco}) and stomatal conductance (Gs) to a decrease in SWC, and short-term increase in VPD, could be described by logarithmic functions. In contrast, the apparent response of tree transpiration (T) and soil CO_2 efflux (Rs) to SWC followed a quadratic curve; after the initial increase with drought, T decreased more than Rs. Watering caused T and Pn_{eco} to remain at pre-drought conditions, while Rs increased. This increase in Rs was mostly due to a strong response of microbial (Rm) respiration, while root-rhizosphere (Rr) respiration was tightly coupled to tree dynamics (Gs, Pn_{eco}). Thus, rather surprisingly, increased soil water availability negatively affected the short-term ecosystem C balance, due to decomposition rates being more increased than photosynthesis. This clearly highlights that understanding the dissimilar response of tree dynamics and soil decomposition to water availability might be a key component in predicting future C sequestration in these water-limited forest ecosystems.

B4-O2: Global pattern of leaf and wood decomposability and its relation to life traits

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Recent global meta-analyses of deadwood and leaf litter decomposition revealed that functional traits and phylogenetic relationships substantially influence decay rates. But it still remains unclear whether decomposability is related between different organs or tissues of a single species. And if so, it this imposed by specific traits reflecting basic plant strategies along the trade-off between conservatism (favoured by durable tissue construction) and acquisition (favoured by the opposite)?

In the past, joint analyses of wood and leaf decomposition were impeded by several obstacles. These were mainly related to the divergence of experimental sites, species and methodical approaches among the conducted studies. Additionally few experiments included both wood and leaf decomposition.

In order to resolve these difficulties we applied a Hierarchical Bayesian modelling approach based on decomposition and associated co-variate data from 207 published and unpublished studies. Our method enabled us to relate dead wood and leaf decomposability for a total of 85 species from all major global forest ecosystems.

Our analysis does not support a general correlation of leaf and dead wood decomposability. This lack of coherency can substantially be explained by decoupled allocation strategies to the two organs, reflected by decoupled leaf and stem wood economic trait spectra. Our results help to improve understanding the investment strategy of plants across organs and its influence on carbon and nutrient turnover.

B4-O3: Global patterns of mobile carbon reserves in trees at the alpine treeline

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Although, alpine treelines are a world-wide phenomenon marking a drastic change in the predominant plant life-form, from upright trees to low stature shrubs or grasses, a conclusive, mechanistic explanation for treeline formation is still lacking. The carbon-sink-limitation hypothesis predicts that tree growth at treeline subsides due to a direct cold-limitation of meristematic growth at otherwise sufficient carbon-supply by photosynthesis. In order to test this hypothesis, we present a synthesis of previously published and new data on the altitudinal trend of non-structural carbohydrate reserves (NSC) in trees along treeline ecotones from 13 different treeline regions world-wide, spanning a latitudinal gradient form 68 °N to 45 °S. Across all investigated sites, NSC concentrations in different tree tissues (leaves and sapwood) were found to increase with altitude, by on average 25 % from closed, tall forest stands to the uppermost aborescent trees at treeline. Because this increase was primarily due to higher concentrations of starch and not low molecular weight sugar, it is unrelated to osmotic adjustment (e.g. freezing resistance) but reflects an accumulation of mid- to long-term carbon reserves. In addition, we present a summary of studies on the effect of low temperature on

NSC concentrations in trees from a common gene pool (i.e. a single provenance), which also revealed significantly higher tissue concentrations of NSC in cold-treated trees. Higher C-reserve concentrations at treeline are thus unlikely the result of an ecotypic adaptation of treeline populations. In accordance with the sink limitation hypothesis of treeline formation, the increased concentrations of mobile carbon compounds in the uppermost trees therefore rather reflect an immediate physiological reaction in response to the imbalance between carbon uptake and carbon investment, with the latter ceasing at relatively higher temperatures than the former.

B4-O4: Holocene migration of *Fagus sylvatica* and *Picea abies*

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Species migration is an essential process with respect to invasive species and climate change. Migration speed and routes can be reconstructed with pollen and macrofossil records for past times. But these reconstructions miss the proof in form of process orientated estimated migration speeds. Several migration models are developed to calculate migration rates regarding environmental conditions. However, vegetation dynamics which influences migration is often reduced to simple assumptions or missing. This results in divergences of observed to modelled migration rates. We hypothesize that competition and vegetation density have a major impact on migration ability. We developed a post process migration tool by translating the outputs of the single species migration model CATS combined with outputs of the DGVM LPJ-GUESS into realistic spread rates. The tool relies on a linear dependency between the dispersal kernel and migration spread rate and is based on two assumptions. First, competition reduces fecundity. Therefore, success declines to immigrate into a new habitat. A reduction of total seed production, which represents the integral of the kernel, reduces with the same ratio the number of seeds along the distance vector between host plant and seed. Second, seed dispersal is limited by vegetation density. Higher density reduces the distance between source plant and dispersed seed. While reduced seed production compresses the kernel along the y-axis, higher vegetation density compresses the kernel along the x-axis. We will present the developed method and results of the migration tool. We applied the tool to the species *Fagus sylvatica* and *Picea abies* and simulated their migration from refugees at 9k BP.

B4-O5: Simulating the impact of Holocene land use on migration of *Fagus sylvatica*

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Species migration has become an important research subject during the last decades. The possible effect of farmland on tree migration is contentious. In general, non-forest land use involves processes which act antagonistic to the migration ability of trees. Open areas may speed up migration, because wind dispersal is facilitated and competition during establishment and juvenile growth is reduced. On the other hand, regular clearing of farmland makes tree establishment impossible and hence restricts migration to isolated stepping stones and reduces landscape-scale seed production. Therefore, whether land use enhances or retards tree migration depends on (1) the particular tree species, (2) land use intensity, and (3) environmental conditions. In a post process module, we combined outputs from the dynamic global vegetation model (DGVM) LPJ-GUESS coupled with the HYDE3.1 and KK10 land use data sets and outputs from the single species migration model (CATS) to simulate *Fagus sylvatica* migration over Europe during the late Holocene (since 9k BP). Within the module, migration rates of the single species model CATS were assumed to be the potential maximum regarding environmental conditions. We developed a novel function accounting for competition, vegetation density, and land use to translate potential to realistic migration speeds. The calculated migration speeds with and without land use implementations were compared to estimate the impact of land use on the migration of *Fagus sylvatica* during the last 9000 years.

B4-O6: Do global change experiments overestimate impacts on terrestrial ecosystems?

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In recent decades, many climate manipulation experiments have investigated biosphere responses to global change. These experiments typically examined effects of elevated atmospheric CO_2, warming or drought (driver variables) on ecosystem processes such as the carbon and water cycle (response variables). Because experiments are inevitably constrained in the number of driver variables tested simultaneously, time and space, a key question is how results are scaled up to predict net ecosystem responses. In this review, we argue that there might be a general trend for the magnitude of the responses to decline with higher-order interactions, longer time periods and larger spatial scales. This means that on average, both positive and negative global change impacts on the biosphere might be dampened more than previously assumed.

B4-O7: The effect of phytoplankton species richness on stoichiometric interactions

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The experimental evidence for the validity of stoichiometric predictions has mainly been assembled focussing on linear food chains, with single species on different trophic levels. These studies often report direct links between consumer nutrient demand, producer nutrient composition and the effects the consumer have on the prey nutrient content. However, most natural ecosystems harbour a variety of producer and consumer species, which may substantially alter the link between consumer presence and prey nutrient content. Despite the considerable progress made in explaining the stoichiometric interplay between consumers and resources, major tenets of this theory remain poorly or not tested. 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 on the stoichiometry of the interaction between marine phyto- and zooplankton species. First results were in line with our expectations that decreased light intensity and nitrogen supply led to lower phytoplankton biomass and abundance compared to non-limited cultures. Consumer grazing rates were higher with -N high light food, indicating compensation for poor food quality. Compared to single species, consumer biomass increased significantly when feeding on mixed algae cultures under light and nitrogen limitation. Producer diversity significantly increased algal and herbivore biomass while altering algal C:N ratios and herbivore grazing rate. Consumer diversity decreased algal and herbivore C:N ratios and altered consumer and producer biomass. Our results indicate that stoichiometric constraints of trophic interactions are mediated by producer and consumer diversity.

Poster Presentations

B4-P1: Below ground carbon dynamics in olive trees in saline conditions

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With food production having to meet growing demand, and global climate change and secondary salinization protruding, understanding plant reaction to abiotic stress is decisive. Salinity is one of the most severe environmental factors limiting the productivity of agricultural crops worldwide. Cultivation of olive is highly encouraged in Mediterranean countries because of its limited water requirement and considerable salt tolerance, which however, varies strongly between cultivars. Salt exclusion capacities of roots are known to play a significant role in salinity tolerance. In addition, less salt affected root systems in terms of root biomass, root turnover and respiration may contribute to sustained yield and above ground growth of salt tolerant olive cultivars. Thus, the objective of this study is to examine the below ground carbon dynamics in olive trees under salt stress.

Two drip-irrigated cultivars of 14yrs-old olive (*Olea europaea* L.) trees, cv. ‘Barnea’ (salt tolerant), and cv. ‘Leccino’ (salt sensitive), were examined in the Negev desert, Israel. Three levels of NaCl salinity (1.2, 4.2 and 7.5 dS m^{-1}) were applied. Bio- and necromass of fine roots, root respiration, and root growth and turnover were determined by soil coring, in-growth core and minirhizotron approaches. The root architecture and morphology as well as salt concentrations were analyzed based-on root orders.

The results will be discussed in respect of whole plant carbon dynamics and root traits underlying the salinity tolerance of tree species.

C1 Herbivory crossing borders: patterns and processes in aquatic and terrestrial systems

Oral Presentations

C1-O1: Dynamics of an island endemic shrub: Herbivores a threat to island biodiversity?

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Plant species and ecosystems on oceanic island have generally evolved in the absence of strong herbivorial pressure. Yet, around the globe introduced herbivores have caused severe damage to natural island ecosystems with a particularly detrimental effect on island endemic species. Interestingly, the spatially isolated, high-elevation desert (codesar) of La Palma (Canary Islands) is dominated by *Adenocarpus viscosus* ssp. *spartioides,* one out of several other endemic shrub (sub-) species, while the other shrubs of this ecosystem are highly endangered or even close to extinction. We assessed the population dynamics and spatial pattern of *A. viscosus* ssp. *spartioides*. Habitat and vitality characteristics were investigated assessing spatial topographic features and tree ring based age estimates. In addition, we analysed plant diversity patterns and growth height of shrubs in communities dominated by *A. viscosus* ssp. *spartioides*as a function of herbivore exclosure. Mean age increased with altitude although vitality analyses indicated that the codesar is elevated above the growth optimum of *A. viscosus* ssp. *spartioides*. All investigated non-dominant shrub species reached a larger canopy height in the exclosures than *A. viscosus* ssp. *spartioides,* but were absent elsewhere, even though these effects were depended on altitude and island orientation. Introduced herbivores (rabbits and goats) seem to be the major disturbance in this ecosystem and pose the biggest threat to native ecosystem biodiversity. Recently, increased fire frequency and recurrent ice storms probably further alter the disturbance regime. This high-elevation desert is an ideal model system for investigating interactions of fundamental processes in nature, due to its small species pool exposed to key ecosystem disturbances.

C1-O2: Antagonistic interactions: effects on plant performance and population dynamics

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Antagonistic interactions with herbivores or pathogens may influence the performance of plants in many ways. Much less, however, is known about whether such effects translate into effects on plant population growth rate and future population size. The major aim of this study was therefore to examine the effects of antagonists on plant population dynamics, using the perennial forest herb *Phyteuma spicatum* as model species. Previous studies have shown that damage by deer can be severe. During several years, I compared vital rates and population growth rates between fenced exclosures, i.e. areas from which deer were experimentally excluded, and grazed control areas. Deer caused the largest damage to flowering individuals. Only few vital rates, however, seemed to be negatively affected by the presence of deer (mainly seed production) and this did not translate into effects on population growth rate. Contrary to expectations, population growth rates tended to be lower in the fenced exclosures in one year. This was likely caused by high pathogen infestation rates, which negatively affected the probability of adult survival and growth. In conclusion, the results of this demographic study show that grazing effects may be overall small for long-lived herbs, and that negative effects on vital rates such as seed production must not translate into effects on population growth rate. The findings further illustrate that other antagonists such as fungal pathogens may be of greater relative importance for differences in population performance.

C1-O3: Temporal habitat preferences in roe deer at different scales

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Patterns of an individual's space use reflect the complex, often competing demands that influence movement behaviour. Numerous studies on habitat preference exist but only few consider temporal variations, even though it is well known that resource requirements of roe deer as well as resource availability in landscape vary over time. In our study, GPS telemetry data of 61 roe deer (35 male, 26 female) were analysed with regard to seasonal and circadian variations of the usage of 25 different vegetation types. We followed two approaches. (1) Preferences, defined as the disproportionality between usage and availability, were quantified for each individual separately under use-availability design at fine temporal scales (hourly, monthly). (2) Data of all animals were combined and fitted via a generalized additive model (GAM) to describe preference with respect to time (daytime and month) for all recorded animals. Apparent temporal patterns of resource preference were detected with both, usage/availability-design and GAM. Significant variations of preference over time indicate changes in resource requirements. Based on expert knowledge, preference for food during night and preference for cover during day could be inferred. Furthermore a sex specificity in site selection was detected, in particular during the course of the year. Does showed a higher preference to sites granting a high energetic gain during pre- and postnatal care. In addition, they appeared to put less emphasis on cover during fawning season.

Our analysis exemplifies the need for incorporating temporal dynamics in resource selection. Habitat preference analysed with respect to temporal varying covariates may facilitate a deeper understanding of movement behaviour of roe deer.

C1-O4: Multiple resource limitation theory applied to herbivores: Liebig's minimum rule?

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There is growing consensus that the growth of herbivorous consumers is frequently limited by more than one nutrient simultaneously. This understanding, however, is based primarily on theoretical considerations and the applicability of the existing concepts of co-limitation has rarely been tested experimentally. We assessed the suitability of two contrasting concepts of resource limitation, i.e. Liebig's minimum rule and the multiple limitation hypothesis, to describe nutrient-limited growth responses of a freshwater herbivore (*Daphnia magna*) in a system with two potentially limiting nutrients (cholesterol and eicosapentaenoic acid). The results indicate that both nutrients are interactive-essential rather than strictly essential, suggesting that consumer growth was not strictly limited by the nutrient in shortest supply relative to demand according to Liebig's law of the minimum. Our results provoke questions on the generality of co-limitation of herbivore growth and imply that resource-based modelling approaches assessing herbivore population dynamics may depend on the applied concept of resource limitation.

C1-O5: Effects of gastropod grazing on epiphytic cryptogam communities

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Gastropods may well have strong effects on lichen abundance and community composition because several species feed on lichens. However, experimental evidence from gastropod exclusion from epiphytic lichen communities in a long term experiment is missing. In addition, whether gastropod grazing also affects epiphytic bryophyte, fungus and algae communities has not been tested. We hypothesized that species richness of lichen communities is promoted by gastropod grazing by reducing interspecific competition among lichens.

In spring 2008 we selected two trees on each of eight chosen forest sites (5 beech and 3 spruce stands) in the Schwäbische Alb. On each tree we placed a vertical grid with five 10 × 10 cm subplots in each direction of the stem and recorded the abundance and grazing damage of all lichen, bryophyte and fungus species as well as the abundance of free living green algae of each subplot. Then, we excluded gastropods from one of these trees by repeatedly applying a barrier of anti slug paste at tree base. In spring 2011 we repeated vegetation records.

In 2008 most lichen species had grazing marks by gastropods while bryophytes were generally unaffected. After three years, grazing damage of all lichen species was decreased significantly when gastropods were excluded but remained similar on control trees. On spruce, gastropod exclusion had no effects, probably because of low gastropod abundance. In contrast, on beech lichen species richness slightly increased in the absence of gastropods while lichen cover was not affected. However, green algae cover strongly increased without gastropod grazing, starting to overgrow lichen thalli.

Our data suggest that release from gastropod grazing temporarily increases lichen species richness and vitality but ultimately will decrease it due to increased competition with green algae. We conclude that gastropods are important drivers of lichen community diversity and composition.

C1-O6: Ungulates limit shrub establishment - large scale study in tundra

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Arctic is among the biomes where climate is predicted to change strongly. One of the more conspicuous processes expected to happen is establishment of tall shrubs in currently open tundra landscapes. Such ecosystem state transition has been predicted to have wide-ranging consequences for ecosystem function and services. The transition would likely have early nuclei in habitats where tall shrub species are currently found, and ultimately manifest in other parts of tundra also transforming to landscapes with closed canopy shrub patches. Rate, strength and spatial pattern in new-establishment of shrub patches at yearly to decadal time-scales would, however, be dependent on performance of currently small-statured shrub recruits. Ungulate browsing can generally limit cover and growth of the recruit stage of shrubs, and in some arctic regions ungulates have become overabundant. Previous studies of tundra shrub dynamics have, however, focused on impacts of environmental drivers to growth of plants in established shrub patches. Hence knowledge of potential for new-establishment of shrub patches is limited. We addressed determinants of shrub establishment in northern Norway, where large scale contrasts in ungulate browsing pressure allowed for encompassing several sub/low-arctic tundra mountain regions. We found that over-abundant ungulates severely limit recruits of tall willow, as measured through several growth and performance variables. The magnitude of ungulate browsing effects appears to over-ride current climatic variability in the region. We discuss possibilities for ungulate management in mitigating ecosystem state transition from open tundra to closed canopy landscapes.

C1-O7: On facilitation, stress and herbivory

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The stress-gradient hypothesis (SGH) predicts a shift in plant communities from net negative interactions in benign environments towards net positive in harsh environments. While several studies found support for the SGH, others found evidence against it, leading to the current debate on how nature and strength of species interactions change along stress gradients, and to calls for new empirical and theoretical work. The role of biotic stress induced by herbivores is thus far largely ignored in this debate, while it was originally part of the first conceptual ideas developed in the early nineties. Yet, there is ample evidence that herbivores strongly alter the net outcome of species interactions in both benign and harsh environments. In this talk I will give several examples of how herbivores drive species interactions in terrestrial and aquatic ecosystems and how increased biotic stress (herbivory) affects the net outcome of these species interactions. Furthermore, I will discuss the consequences of including both biotic and abiotic stress factors (combined) for the SGH and how this might work in various ecosystems.

C1-O8: Facilitation in herbivore communities

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Positive interactions are increasingly recognized as an important mechanism structuring plant and animal communities. Positive interactions have been well documented in herbivore communities. Large herbivores facilitate smaller ones by increasing access to plants and improving plant quality. In an exclosure experiment, we show that rabbits prefer vegetation grazed by cattle. Subsequent clipping and fertilization experiments show that removal of tall unpalatable grasses and an increased quality of plants after fertilization both attract rabbits. However, there is little synthesis of when facilitation in herbivore communities occurs. There are contrasting theoretical models on the role of facilitation along productivity and predator pressure gradients which predict either a linear increase or a peak of facilitation strength at intermediate levels. Whereas these predictions are now being tested in plant communities it remains unclear whether this would also apply to animal communities. We tested the interaction between a bulk grazer and a specialist herbivore along a productivity gradient by using pond snails (as bulk grazer) and aquatic caterpillars (as specialists) grazing on algae and a macrophyte as a model system.

C2 Evaluating the drivers of biodiversity patterns: plant-animal interactions and relationships with environmental variables

Oral Presentations

C2-O1: Identifying the drivers of biodiversity: the role of plant-animal interactions

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The study of plant-animal interactions has played a central role in the development of ecological and evolutionary theories. Quantifying plant-animal relationships is ultimately critical to explaining biodiversity patterns at multiple spatial scales and to developing sound management and conservation strategies. Over the past decade, there has been an increasing interest in the study of such relationships to identify potential surrogates for biodiversity in both terrestrial and aquatic ecosystems. If strong and consistent plant-animal relationships are found, it is plausible to collect information on the vegetation to predict patterns for other animal groups, allowing conducting cost-effective and rapid biodiversity surveys. Plant-animal relationships may be a function of 1) trophic relationships, biotic interactions such as competition or facilitation mechanisms, 2) a similar response of these taxonomic groups to the same set of environmental conditions, or 3) random factors. Here, a review of the literature on this sub-discipline of ecology, which may range from molecular to global scale studies, will be provided. A description of analytical procedures that can be used to evaluate plant-animal relationships at different spatial scales will also be made. The rationale to improve our understanding of plant-animal interactions to predict patterns of biodiversity and species distribution will be provided.

C2-O2: Effects of the spatial scale and the type of predictor on cross-taxon congruence

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A major challenge in conservation planning and in biodiversity surveys is the identification of reliable surrogate taxa as effective shortcuts for the preservation of the biodiversity. The effectiveness of the surrogate taxa depends on different factors, like the spatial scale of analysis and the type of predictor variable. In this work, the effect of the grain size and the choice of predictor variables was explored on the strength of the community congruence relationships among vascular plants, bryophytes and lichens. Data for these three taxa collected by a multiscale design based on a restricted random sampling applied in the “Bosco di S. Agnese” Nature Reserve (Tuscany, Italy). Co-correspondence analysis (Co-CA) was performed on (i) two different response taxa (e.g. bryophytes and lichens presence/absence data) considering (ii) three different matrices of predictor variables (presence/absence of vascular plant species, abundance of vascular plants and a structure-based dataset) for (iii) the three grain sizes available ($1m^2$, $100m^2$, $1000m^2$). Results obtained from the Co-CA were analyzed using three-way ANOVA. From a general point of view, our results revealed weak explanatory power of vascular plant composition with respect to bryophyte and lichen communities. Noteworthy, the effects of the spatial grain and the type of predictor variable on the strength of congruence among the considered taxonomic groups provided two main results: i) the amount of explained variance varies with the grain size; ii) the sign of observed relationships mainly depends on the analyzed taxon and on the choice of predictor variables. Concluding, the choice of grain size, taxon and type of predictor variables are so essential that could be the cause for the inconsistent results observed in previous studies examining the congruence among taxonomic groups and potential effectiveness of surrogate taxa.

C2-O3: Plant diversity changes network structure of multitrophic interaction webs

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Background/Motivation /Methods

In the face of the currently unprecedented loss of species, it is of great importance to understand the consequences of this loss for the structure and functioning of ecological communities. Plants are at the base of terrestrial food webs and trophic bottom up effects are considered to be very strong. We tested the theoretical prediction that reduced diversity of plant species results in a less complex network structure and reduced interaction diversity of the multitrophic ecological networks basing on them. We used plant biomass and arthropod abundance data from the Jena Experiment and classified the 427 insect and spider species to 13 functional groups using cluster analysis. Using these functional groups we calculated multitrophic functional group interaction webs and compared communities based on differing plant species richness.

Results/Conclusion

Interaction webs basing on less diverse plant communities showed reduced complexity in terms of connectance as well as diversity and strength of interactions among functional groups. The strongest effects were found for interactions between adjacent trophic levels indicating that these were mainly trophic interactions, while significant interactions among plant and carnivore functional groups were generally rarely present. Reduced interaction diversity has the potential to decrease and therefore destabilize ecosystem processes. We conclude that the loss of basal producer species leads to more simple structured and less linked species assemblages which may have crucial implications for the stability of the whole community.

C2-O4: Cross-taxon congruence of six species groups in European farmland

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In the EU FP7 project BioBio, potential biodiversity indicators are currently being examined in 16 - 20 farms within each of 16 case study regions across Europe. Each case study region represents a typical production system (i.e. specialist field crops, horticulture and permanent crops; specialist grazing with cattle and other livestock types; mixed crop and livestock farming). 28 candidate indicators for genetic, species and habitat diversity as well as 14 indicators for agricultural management practices which relate to biodiversity were selected. Vascular plants, earthworms, spiders, bees, butterflies and grasshoppers were assessed in typical fields and habitats of the agricultural landscape following a standardised design and common methods. Here, the cross-taxon congruence of these six species groups in a mountainous region of Switzerland is investigated and compared with other case study regions. The findings provide information on appropriate surrogates as indicators to estimate biodiversity in farmland.

C2-O5: Effects of landscape context and management on natural enemies of insect pests

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Landscape context and management intensity are major determinants of biodiversity patterns in agricultural landscapes, however it is still unclear how they influence the distribution of natural enemy species and their efficiency for biological pest control. In the intensively cultivated agricultural landscape of the Haean catchment, South Korea, we investigated the influence of landscape structure and local management on the abundance and diversity of insect natural enemies in crop fields, and on their performance for pest control at multiple spatial scales. Birds, syrphid flies, parasitoid wasps and predatory beetles were thus sampled in 32 annual crop fields differing in landscape context and management intensity. Associated herbivory rates and crop biomass were measured in the same fields. We then tested the hypotheses that enemy diversity and abundance are higher, and associated damage rates lower, in landscapes with higher proportions of non-crop habitats, and that different organisms are affected by landscape context and management at different spatial scales. Moreover, although damage rates did not differ between organic and conventional management, we found predator richness and abundance to be higher in organic fields, suggesting that natural enemies may effectively compensate for reduced pesticide application in less-intensively managed fields.

C2-O6: Specialization of plant-pollinator systems and community stability

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A major task for ecologists is to identify traits that affect the vulnerability of species and communities to environmental change. Ecological specialization has often been proposed as an important traits that influences robustness to disturbances. Whereas good support for a positive relationship between ecological specialization and vulnerability at the species level exists, few studies have explored the relationship between specialization and stability at higher levels of organization. Moreover, most previous studies have focused on dietary specialization of predators on prey organisms, while other types of ecological interactions have largely been neglected. Here, we present a study of the relationship between specialization of plant-pollinator systems and community stability that uses a recently developed mechanistic model of plant-pollinator dynamics. Since previous analyses have shown that without further assumptions coexistence of multiple plant and pollinator species is unstable due to a reproductive disadvantage of rarer species, we first introduce a classical stabilizing mechanism, niche differentiation of plant species in competition for space. Two measures of community stability were calculated as a function of pollinator specialization and degree of plant niche overlap: Resilience, the return rate of the system after a small perturbation, and the size of the attractor region around the coexistence equilibrium. Whereas resilience increased with increasing pollinator specialization, the size of the attractor region showed a bimodal pattern. The results of our analyses show that the relationship between specialization and stability depends on the level of organization studied as well as the concept of stability applied.

C2-O7: Consumer diversity and identity effects on natural prey in aquatic food webs

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A number of recent studies have investigated the effects of consumer diversity on prey assemblages by manipulating their richness. It turned out that food web configurations critically affect the outcome of such experiments. A recent modelling approach confirmed that these configurations can profoundly influence ecosystem processes.

In our study, we investigated the effects of consumer diversity and their degree of specialization on prey biomass, diversity and composition in microbial microcosms using herbivorous ciliates as consumers and microalgae as prey. Three consumer diversity levels were established altering consumers richness and specialization by adding differently specialized ciliate species to a natural phytoplankton prey community. Ciliates differed in feeding preferences and grazing rates, but also in feeding strategies. The presence of natural ciliates was taken into account in our data analysis. Additionally, we added *Daphnia magna* to half of our treatments to enhance the complexity of our food web.

Although we found no diversity effects of the manipulated ciliate assemblage on algal biomass, producer evenness was affected negatively by ciliate diversity. Furthermore, identity had negative effects on the natural ciliate assemblage with regard to their biovolume and evenness. Negative bidirectional interactions were also detected between *Daphnia magna* and the manipulated ciliates, whereas *Daphnia magna* itself reduced biomass of both prey and natural ciliates. In conclusion, our study indicates that diversity and identity of intermediate consumers are important factors shaping communities within and across different trophic levels in aquatic food webs.

Poster Presentations

C2-P1: Plant functional types which favour the installation of predatory mites

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Plants with special functional types may favour the establishment of predatory mites to protect crop plants from pests. The addition of such plants to crop systems can have positive effects on the productivity of crops and enhance biological pest control. Additional plants such as banker plants may provide shelter or food for beneficial organisms which influence the interactions between phytophagous arthropods, beneficial organisms and culture plants. However, despite the clear function of their presence, there is a lack of scientific knowledge of why plant species act as banker plants, and which plant morphologies and structures enhance the desired proliferation of the beneficial organisms. Consequently, only few species of banker plants are in use. If we know more about the morphologies which bear positive implications for the crop system, we can choose additional local plant species instead of potentially invasive ones. We then can increase the efficiency and optimization of banker plants in biological pest control. In order to analyse which plant functional types enhance the reproduction of predatory mites, we chose 8 species of plants differing in plant architecture, the presence of pubescence, domatia or waxes, leaf texture, etc. The results showed that in a system with rose crops, spider mites (*Tetranychus urticae*) and predatory mites (*Amblyseius californicus*), plant growth and the development of both pest and predator mites was clearly affected by the presence of banker plants. Two plant species were responsible for best predator installation and rose growth, both of which had acarodomatia on their leaves which favoured the installation of predatory mites. With this knowledge, practical solutions for biological pest control as an alternative to chemical control are optimized with the aid of additional plants in the system.

C2-P2: Predation on artificial caterpillar models across a disturbance gradient

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One possible mechanism underlying caterpillar losses in the tropics is an increase in predation due to habitat degradation, and changes in predator communities. Leaf rolls have been assumed to protect caterpillars against predators, and recent experimental evidence confirms that leaf refuges improve caterpillar survivorship especially in the presence of birds, ants, or wasps. But leaf refuges can also serve as a clue to predators. Some observations suggest that they are not always effective protection against birds and wasps that are able to open leaf folds.

Therefore, relative levels of predation on exposed and concealed artificial caterpillar models were compared across a gradient of disturbance in Papua New Guinea. Four 2250-m transects were established in each habitat type (lowland closed-canopy primary forest, lowland open-canopy primary forest, lowland secondary forest, and primary forest at 1700m a.s.l.) where artificial caterpillar models were placed on 30 trees per plot and checked after every 24 hours of exposure period for 5 days. In total, 3000 caterpillars were exposed in each experimental plot.

General linear mixed model analysis suggested that effects of habitat type on caterpillar predation differed significantly among plots. However, concealed caterpillars were predated less (13.5%) than exposed caterpillars (26.27%) in all experiment. Attacks on caterpillars increased with disturbance (19.78% - 34.5%), and attacks were also more frequent at higher elevation (34.5%). Markings on plasticine models were used to establish possible predators. Ants were the most common predators in disturbed areas (10.2±0.45%), and less common at higher elevation (4.8±0.3%). Birds predated most of the caterpillars at high elevation and compensated for missing ants. The other important predators were wasps, parasitoids, and mammals. Shifts in predator dominance among the habitats were observed in most of the plots. Vegetation cover, tree density and were correlated with mean predation in transects.

C2-P3: Soil heterogeneity does not explain a boreal productivity-diversity gradient

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Many studies at the regional scale have found either negative or hump-shaped relationships between productivity and diversity, and some theories propose that these occur because soil resource heterogeneity is either lower or less important in more productive environments. However, there have been few explicit tests of these theories in natural ecosystems. We evaluated the relationship between soil resource heterogeneity and plant richness within a well characterized system of 30 islands in northern Sweden across which soil fertility and therefore productivity declines, and species richness increases, as a consequence of ecosystem retrogression. On each island we quantify spatial heterogeneity of five soil variables (NH_4^+-N, amino N, PO_4^--P, microbial biomass, and decomposition), and plant community composition. Using a hierarchical Bayesian approach, we estimated mean semivariograms of each variable for each island size class to compare three components of spatial heterogeneity: total variability, spatial grain, and patchiness. This analysis showed that within island total variability of soil variables was usually lowest on small islands, where species richness was highest and productivity lowest. We did not detect any significant across-island correlations between whole-plot plant species richness and either whole-plot standard deviation or coefficient of variation of any soil variable. Using partial Mantel tests, we found that mean correlation coefficients between within plot plant community composition (i.e. 2 PCA axes) and the five soil variables were never significant for any island size class, and did not differ between island size classes. Our findings therefore did not provide any evidence that soil resource heterogeneity controls the productivity-diversity relationship in this system, and suggests other mechanisms are primarily responsible.

C2-P4: Phylogenetic community structure of ant communities along a succession gradient

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The mechanisms leading to phylogenetic community structure in local assemblages have become a major focus in recent community studies. Studying the phylogenetic structure of an ecological community can provide insights into the relative importance of different processes structuring that community. We aimed at measuring the phylogenetic structure by determining the processes structuring the ant communities occurring in 12 sites along a forest succession gradient, in the tropical secondary forests of Brazil. Two null models were applied on the metrics, in order to detect potential processes generating the community patterns. We also tested the influence of metrics used, succession and taxonomic scale, on the estimates of phylogenetic community structure. The observed over-dispersion and clustering across the sites depended on the metric and null model used, and to an extent the forest succession stage, possibly due to variation in the strength of ecological processes among habitats or distribution of ecologically important traits. On average, the phylogenetic structure of ant communities was clustered when a single ant genus *Pheidole* was used, while over-dispersion was observed when several ant genera were in consideration. This suggests that competition is increasingly evident as ant communities are defined to include greater phylogenetic diversity. That a single ant genus *Pheidole* likely forms non-interactive assembly is a notion in contrast with many studies which suggest that competitive interactions structure closely related communities. Our findings show that the phylogenetic structure of ant communities depends on interplay of several factors, most of which still need to be comprehensively researched on.

C2-P5: Ontology-based data-integration on biotic interactions in a changing climate

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The ecological consequences of climate change in all their dimensions are not yet fully understood. In this context, data integration by means of ontology is a novel tool to deal with data heterogeneity and complexity. The application of ontology offers the possibility to interlink ecological data beyond data treatments within single disciplines. The Bavarian research cooperation FORKAST ("Climatic Impacts on Ecosystems and Climatic Adaptation Strategies") integrates 17 different sub-projects across various ecological disciplines. Here we integrate data from three sub-projects working on the impact of climate change on the biodiversity of mountain grasslands in the National Park Berchtesgaden, Germany. Specifically, we use our own data and available databases across different trophic levels to design a semantic web which was derived by the Extensible Observation Ontology (OBOE, Madin 2007). In this way, new ecological hypotheses and research gaps may be identified, e.g. within the field of biotic interactions and their outcome for ecosystem functions such as phenology and pollination. Besides extant application, an ontology-based data organization allows for further specific evaluations independent from the data collector and without loss of data and metadata information. Our paper aims to push the frontier of ecologically focused climate change research toward a more intense interdisciplinarity.

C3 Seed dispersal and predation: Interactions, ecosystem functions and services

Oral Presentations

C3-O1: Why is the rare dispersal mechanism hygrochasy so common around the world?

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Hygrochasy, the opening of a fruit in response to moisture and subsequent dispersal of seeds via raindrops, is predominantly known from plants in arid regions. The evolution of this unusual dispersal mechanism is mostly associated with temporal and spatial dispersal restriction, the spreading of germination risks, safe site strategies or protection against seed predators. In recent years, however, hygrochasy was also shown in a number of plant species from different, non-arid habitats around the world.

The aim of this study was to test whether hypotheses developed for hygrochasy in plants of arid regions apply to unrelated hygrochastic species in different habitats globally.

Hygrochastic species of the Aizoaceae (Southern Africa) and *Veronica* (Plantaginaceae) (New Zealand) were compared with hygrochastic *Oenothera* (Onagraceae) (Northern America) in dispersal experiments and cluster analyses of morphological data, environmental and distribution data was carried out. Character evolution of dispersal mechanisms was also traced in all study groups.

For Aizoaceae and *Veronica*, strong support for some hypotheses was shown, whereas most present day hygrochastic *Oenothera* do not seem to conform to them. However, *Oenothera* evolved as part of the Madro-Tertiary flora, when the temporal restriction of dispersal might have played an important role in response to dry, highly seasonal climate with unpredictable rainfall and hygrochastic capsules would have been highly advantageous. Therefore, hygrochasy seems to be an ancient relict, which is still present in most species of one *Oenothera* subclade.

In conclusion, hygrochasy is a very successful strategy for various plant taxa if the restriction of dispersal in space and time is advantageous, for example in regions with restricted rainfall or a heterogeneous environment with small suitable habitat patches.

C3-O2: Dispersal distance as a limiting factor for vegetation recovery in arid systems

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Many species from arid environments evolved towards short dispersal distances to cope with the patchy distribution of favourable microsites for germination and establishment. Recruitment is most likely to be successful near the mother plant in vegetation patches functioning as safe sites. The persistence of a plant population depends to varying degrees on the local seed production, recruitment from soil stored seeds and arrival of diaspores from nearby plant communities. We analyzed the similarity of seed bank communities of different microsites across a fence-line in arid shrublands of Namibia. Microsites included shrubs, which proved to effectively trap dispersing seeds and accumulate large and diverse seed pools in understorey soil. Despite a long history of contrasting grazing regimes, seed bank communities were still similar in composition, with short-lived, atelechoric species depending on regeneration by seed being represented the most. However, high grazing pressure increased abundance of species with vegetative traits and diaspore traits permitting them to persist. This excluded key species important for ecosystem functioning, such as the anemochorous grass *Stipagrostis uniplumis*. The presence of only a very few remnants in standing vegetation and its nearly depleted soil seed bank even in refuge providing shrub understoreys suggest that sexual reproduction is hindered by grazing livestock, and the arrival of diaspores from populations at the adjacent rangeland is insufficient. Overall, the low amount of seeds of species negatively related to high grazing pressure across microsites in the degraded environment indicates that the replenishment of seed banks governed by secondary dispersal is provided for local species pools only. Consequently, the restricted dispersal ability of many plant species from the arid Nama Karoo can be regarded a major limiting factor for local survival and re-establishment in a post-grazing scenario, respectively.

C3-O3: How pollen and seed dispersal shape spatial genetic structure of Neotropical figs

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In most tropical tree species, seeds and pollen are dispersed by animals. As they are often very mobile, the direct assessment of dispersal distances is a challenging task. Genetic methods allow determining the spatial genetic structure (SGS) in plant populations and thus, the indirect assessment of the spatial scale of gene flow via seed and pollen dispersal. In Neotropical *Ficus* species (Moraceae), pollen is transported over large distances (>> 1 km) by mutualistic fig wasps (Agaonidae). Fruit-eating bats (Phyllostomidae, Chiroptera) are the main seed dispersers for many *Ficus* species. They effectively disperse large amounts of viable fig seeds, but actual dispersal distances are unclear. We used highly polymorphic microsatellites to determine SGS

in several *Ficus* species from tropical lowland forests in the Barro Colorado Nature Monument, Panama.

Bayesian cluster analysis did not reveal any population substructure for *F. insipida* sampled at different sites along a 40 km stretch of the Panama Canal. Thus, there seems to be substantial gene flow that we attribute to the long distance pollen dispersal by wind-borne fig wasps. However, we discovered significant SGS at a smaller scale: kinship–distance curves revealed significant SGS below 500 m. As pollen dispersal can be disregarded as a cause for SGS at this spatial scale, it strongly indicates spatially restricted seed dispersal. As phyllostomid bats use temporal feeding roosts for fruit consumption which are generally located within 50 – 200 m around the fruiting tree, we propose that most seed dispersal events take place within the range of temporal feeding roosts.

C3-O4: Realistic seed mimics to model dispersal and seed bank development in grasslands

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Though surface dispersal and seed bank formation are key issues in population dynamics, still little is known about importance of factors involved. Our project uses realistic seed mimics made of polyethylene and with size, shape and specific gravity in the range of Central-European seed flora.

We model long-term surface dispersal and burial of seed mimics. The effect i) of size and of shape of propagules (small/large, round/flattened), ii) of soil type (light Humic Sand/heavier Meadow
Solonetz) and iii) of management (fenced/grazed) were studied.

Experimental plots were established in various lowland grasslands in East-Hungary. Particle size distribution and penetration resistance of studied soils has been correlated with the mimics' burial rate.

Altogether 320,000 beads have been placed in autumn 2008. Sampling occurs two times a year. Digging of small soil monoliths, cutting thin layers then washing out of plastic beads through a set of sieves are main steps of data collection.

Clear effect of bead size, of physical soil conditions and of management on dispersal and burial were found. 1) Lower recovery rate of beads in grazed sites compared to fenced ones indicate significance of domestic livestock in dispersal. 2) Surface dispersal of large beads was more affected by grazing than of smaller ones. 3) Smaller beads moved to deeper layers in a larger portion than did the large ones. 4) In Solonetz sites more beads penetrated into deeper layers than on Sand ones, which can be linked to the formation of more stable macropores in Solonetz due to its finer texture. 5) Contrary to other published results, no significant effect of shape on vertical seed displacement or surface dispersal was found. 6) Penetration proved slow as most beads still stay close to the surface after 18 months. On sand only 10% of the recollected small and 4% of large beads sunk from the uppermost 12.5 mm layer while 96.0% of small and 98.7% of large ones still can be found in the upper 25 mm.

C3-O5: Crucial phases in the failing seed production of declining juniper populations

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The latest decades different studies recorded a dramatic decline of common juniper (*Juniperus communis*) in northwest European lowlands. An important cause of this decline is the lack of natural regeneration. Low seed vitality seems to be one of the main bottlenecks in this process. Although a negative relation between both temperature and nitrogen and seed viability is revealed, the underlying mechanisms remain unsolved. In order to unravel this puzzle, it's important to understand in which phases of the seed production the main defects are situated. In this study, we compared the seed vitality of populations with and without recruitment. We examined three seed phases: (1) gamete development phase; (2) fertilization and early embryo development phase; (3) late embryo development phase. We studied over 3000 seeds and found that the percentage of viable seeds after the first two phases remained the same for populations with or without recruitment. After the last phase, populations without recruitment showed a significant lower percentage of viable seeds. These results suggest that the late embryo development is the problematic phase in seed development. To unravel the mechanisms behind the low seed vitality of common juniper further research should focus on this phase.

C3-O6: Does gastropod seed dispersal facilitate herb migration in beech forests?

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European beech forests harbour a diverse and abundant herb community. Many of these herb species are thought to be ant-dispersed (myrmecochores). However, ants can be rare in mature beech forests due to unfavourable conditions and thus seed dispersal might be limited. In a recent study, slugs were identified as seed dispersers of myrmecochores in a Central European beech forest and thus might substitute ants as dispersers. Here we used 105 beech forest plots to test whether myrmecochore presence and abundance is related to ant or to gastropod abundance and whether experimentally exposed seeds are removed by gastropods. We also used a modelling approach to estimate seed dispersal distances by red slugs (*Arion rufus*). Myrmecochorous plant cover was positively related to gastropod abundance, but negatively to ant abundance. Gastropods were responsible for most seed removal and elaiosome damage, while insects (and rodents) played minor roles. The seed dispersal distances by red slugs averaged several meters, exceeding the distances by many ant species and matched well with migration rates of herbs in forests. We suggest that these terrestrial gastropods can generally act as seed dispersers of myrmecochorous plants or even substitute myrmecochory. Gastropods might be of great importance for herb migration in forests.

C3-O7: Landscape factors affecting Parakeet damage to sunflower fields in Israel

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The Rose-ringed Parakeet (*Psittacula krameri*) is invasive in many countries throughout the world. As this cavity-nesting bird is aggressive, it is considered to harm local bird populations by using their nesting places and reducing their breeding success. The Parakeet is also a pest to agriculture, where it affects sunflowers, pomegranate, pecan nuts and maize crops. In sunflowers, they visit the fields in big flocks and consume large amounts of seeds. Interestingly, only some farmers in our research area, in the Judean Foothills in Israel, reported damage, while others did not have problems caused by birds. Our goal was to determine if habitat elements in the surrounding landscape of sunflower fields affect Parakeet damage to crops. We assumed that structures which serve as resting places and watch points, also called bird-standing-points (SP), influence the damage mediated by the Parakeet. Trees, fences and electric lines have been considered SPs in this research. We measured the distance to the closest SP and estimated the crop damage by counting absent seeds of 50 sunflowers. Data collection was done at the border of the field closest to SPs to compare it with sunflowers in the centre of the same field as well as with sunflowers at the other side of the field. Data has been collected across 20 fields. Bird SPs within a range of 50m in the surrounding landscape of the sunflower fields increased the damage to harvest with an average of 16%, with a maximal damage of up to 57%. But when the distance between the closest SP and the sunflower field was less than 50m we found on average less than 0.3% damage. To reduce damage made by birds, farmers should avoid growing sunflowers closer than 50m to SPs. By helping farmers to reduce crop damage, aspects of agriculture and nature conservation can be combined. With better planning, Parakeet habitats can be reduced, with the long-term conservation goal to control the populations of this invasive bird species.

C3-O8: Nectar robbery influences pollinator behaviour and pollen transport

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It has been thought that nectar robbery is detrimental for a flower and its reproductive success. However, evidence is rising that even floral parasites sometimes contribute to pollination or change the behaviour of actual pollinators which increases the chance of cross pollination. A species that could profit from higher amounts of outcross pollen is *Aconitum* *napellus* spp*. lusitanicum* (Ranunculaceae), a species suffering from inbreeding depression which has been reported to be pollinated but also robbed mainly by bumble bees.

We tested whether simulated nectar robbery would influence flower visitor behaviour and the distance and amount of possible pollen transport. We set up experimental patches of five plants each where about 50% of the flowers were manipulated: 1) nectaries were cut to simulate theft; 2) corollas were sliced to simulate robbing; 3) flowers were protected against robbery, or 4) left untreated. Preliminary results show that bumble bees (*Bombus pascuorum*) visited less flowers per inflorescence in patches were corollas had been sliced (Kruskal-Wallis: $\chi^2 = 8.63$; $p < 0.04$) and spent less time on artificially robbed flowers ($\chi^2 = 35.77$; $p < 0.001$).

In a second experiment, we marked anthers of flowers that had been artificially robbed or left untreated (control) with fluorescent dye (pollen analogue) and collected the stigmas of flowers along a transect. The proportion of stigmas with dye as well as the abundance of dye declined much quicker with distance for the robbed transect (less than 70% at 10 m compared to still 100 % at 35 m) and high dye abundance (with > 100 particles only up to 5 m compared to 13 m) indicating that flower visitors indeed left the unrewarding patch quicker and flew farther.

C3-O9: The effects of limited resources on predatory hoverfly *Episyrphus baltaeatus*

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The foraging behaviour of aphidophagous predators is key in conservation biological control more so for species relying as larva and adult on different foods. For reproduction pollen is essential while carbohydrates are necessary to maintain foraging activities. In agricultural landscape *Episyrphus balteatus* is one of the most important aphid specific predators. However, in these fields the spatial and temporal patterns of crops changes and hence food availability also varies. This may prohibit syrphids effectiveness. Thus, an understanding of their foraging behaviour is necessary. Therefore we studied the impact of resource availability on egg laying. Individual mated female syrphids were released in net cages with a rape plant infested with *Brevicoryne brassicae* while pollen and sugar were manipulated to simulate limited food resources. As a control, pollen and sugar were provided throughout the lifespan while the treatments included: pollen only, sugar only, withdraw of pollen from 1st to 11th day and from 11th to 25th day. The laid eggs were counted daily and foraging behaviour was recorded with a video observation system. The results show that in general syrphids contacted the food patch quite often before day 11. From day 11 onwards egg laying started, but visiting frequency decreased. When syrphids fed on pollen and sugar throughout their life span they laid 2 times more eggs as compared to different shortage treatments. In general the highest longevity occurred if pollen and sugar were available, while feeding on sugar reduced longevity to halve. These results demonstrate that pollen availability is essential for syrphid survival and egg laying. Consequently, a lack or sparse distribution of pollen sources in syrphid food patches at the beginning of its life cycle strongly impairs egg laying intensity and reduces longevity.

Poster Presentations

C3-P1: Recent dispersal of two regional adventives in an East-Hungarian landscape

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Propagule limitation often forms a major constraint in plant dispersal. The rate of invasiveness of species varies greatly according to propagule production and dispersal capacity. Mechanisms affecting regional and transcontinantal adventives are basically identical.

Species capable to exploit human transport facilities and to tolerate increased disturbance frequency can act as invaders.

Invasion of two annuals, *Secale sylvestre* (Poaceae) and *Myrrhoides nodosa* (Apiaceae) has been analysed in East-Hungary to reveal the importance of specific traits for contrasting dispersal abilities. Both species have been detected in the region first in the last decade and their spread has been documented through repeated mappings.

The submediterranean Myrrhoides, found first by an abandoned camping in Nagyerdő forest of Debrecen, has shown slow dispersal along forest paths. Accidental establishment of far-lying outposts then gap filling between occupied stands are its main dispersal features. Heavy seeds is a likely reason for slow dispersal. The persistent seed bank can, however, guarantee population survival when early weed control prevents seed set. Late cutting after seed set can promote dispersal and help the plant to leap major dispersal barriers (paved roads, tram lines). We assume that the species will occupy the forest in the next few decades.

The psammophyte, Secale, possibly introduced to the Nyírség region by Robinia saplings from Central Hungary, became already established on a 80 km^2 area Its preferred habitats include young, regularly rototilled Robinia plantations and adjacent sandy grasslands. The major dispersal tools are the cultivation machinery and ectozoochory by grazing sheep.

Its excellent dispersal capacity stems from long, hairy aristae and fragile spike axes. Analysis of soil seed bank of Secale dominated Robinia plantations revealed no persistent seeds. Its further spread is very likely as most suitable habitats are still unoccupied within the region.

C3-P2: Organic farming effects on fitness and seed predation of phytophagous carabids

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Organic farming enhances the diversity of many taxa, amongst them the abundance and richness of vascular plants. Yet, while organic farming benefits many plant species of conservational interest, it also leads to a considerable rise in the number and phytomass of undesirable arable weeds. High abundance and diversity of plants in organically managed fields, however, also go along with high abundance and diversity of seeds. Thus, organic farming may not only increase plant diversity but also biological weed control by providing ample resources for seed predators, such as carabid beetles. To detect the impact of agricultural management on the condition of seed predators and their feeding activity, we carried out cafeteria experiments with four arable weed species and the carabid *Harpalus affinis* from winter-wheat fields that were either organically or conventionally managed and with high or low shares of organic fields in their surroundings. Body size of carabid beetles was significantly higher in fields with an organic context, independent of the local management. This indicates that in spring, when *H. affinis* predominantly breeds, beetles will find more resources in the organic than the conventional landscape. Since carabids switch between different localities in their life cycles, however, this impact of management may not be detectable at the field but rather at the landscape scale. In addition, highest seed predation immediately after field collection and no difference in the beetles' condition between treatments suggest that later in the season, *H. affinis* was generally food limited. Further studies are required to determine whether the positive impact of the amount of organically managed fields on body size and the tendency of larger beetles to consume more seeds de facto results in an increased potential of carabid beetles to successfully control arable weeds in organic agriculture.

C3-P3: Crop seed predation by ants, pesticides, and farmers' income in Indonesia

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Tropical small-scale farmers rely on sustainable food production, but crop seed predation by ants can cause significant food and income losses. Here, we used household questionnaires and an experiment to quantify the hitherto unstudied effect of seed predation on four vegetable crop species (eggplant, cucumber, chili pepper and carrot) and the resulting impacts on net income of smallholders in Sulawesi (Indonesia). Because pesticides were routinely applied, four insecticide and herbicide treatments were implemented in 15 vegetable plantations to assess their effect on ant seed predation. Mean percentage of seeds removed or damaged per plot was 42%, 49.4%, 48%, and 50.6% for cucumber, eggplant, chili, and carrot, respectively, and was halving the farmers' income after considering initial and operational costs. Interestingly, none of the pesticide applications had an effect on seed predation quantity. While pesticide treatments can have positive or negative effects on ant abundances, depending on the species identity, there was no effect on the abundance of all ant species. In addition, at least one dominant ant species occurred on each plot, but the two most abundant species rarely occurred on the same plot. Given the consistently high abundance of ants on all plots and the compensating pesticide effect on ant species, the consistently high predation rate appeared to be due to functional redundancy across plots. We suggest that overseeding could be a promising and environmental friendly approach increase crop yield.

C3-P4: Pollen beetles and pollinators on Brassicaceae species differing in plant size

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Plant species need to cope with herbivores reducing their fitness. In Brassicaceae, pollen beetles (*Meligethes sp.*) belong to the most important herbivores on Brassicaceae, because they can destroy high percentages of flower buds and thereby inhibit the development of pods and seeds. Counteractively, pollinators raise the fitness of plants while increasing seed set through effective pollination. In this study we focus on the relative role of plant height, flower diameter and estimated flower cover on the abundance of pollen beetles and pollinators across Brassicaceae species differing in plant height. We tested the hypothesis that pollen beetles and pollinators are most attracted by plant species offering a high quantity of food resources in that they are big and have large and numerous flowers. We established a common garden experiment using 25 Brassicaceae species differing in size (four 1 m^2 plots per plant species). Plant height gradient ranged from species with mean heights of 6 cm to 115 cm. We assessed the number of adult pollen beetles on flowers of 10 plant individuals per plot at the time of full blossom. Flower visiting pollinators were recorded at plot level during 5 min observation intervals that were replicated three times at the time of full blossom. Numbers of pollen beetles ranged from 0 to about 4430 per m^2, number of pollinators from 4 to 82 per m^2. Results show that pollen beetle abundance is positively related to plant height and flower diameter while no effect of flower cover could be shown. Pollinator abundance is positively related to plant height and flower cover while no effect of flower diameter could be shown. Thus, high plant species appear to be more apparent to their herbivores such as pollen beetles, reducing their fitness, as well as to their pollinators, increasing plants fitness. The advantage of being tall and attractive to pollinators appears to come at the cost of being more attacked by enemies.

C4 Ecological Interactions

Poster Presentations

C4-P1: Relative importance of mixotrophy along gradients of light and loss-rates.

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Mixotrophic organisms are able to combine photoautotrophy and phagotrophy as modes of nutrition. Therefore mixotrophs require cellular structures for both, photosynthesis and phagotrophy. This trade-off affects the competitive success of mixotrophs in microbial food webs. Moreover, the potential simultaneous role of a mixotroph as a competitor and as a predator to more specialized organisms (such as pure autotrophs) leads to a reconsideration of the classical theory of the microbial food web.

We studied the competition between mixotrophic (MF) and heterotrophic flagellates (HF) in artificial food webs, applying gradients of light and loss rate in continuous cultures (chemostat).

Given that the mixotrophic strategy depends on the availability of light and that mixotrophs exhibit a lower minimum prey concentration for zero net growth but show considerably lower maximum growth rates as opposed to heterotrophs, the outcome in the competition between MF and HF is predicted by the combined effect of light and loss rate. Since mixotrophs may utilize nutrients ingested with their prey more efficient compared to heterotrophs, nutrient turnover in microbial food webs should depend on the dominance of MF vs. HF, enhancing conditions favourable for MF under dominance of MF and vice versa.

C4-P2: Non-consumptive effects of spiders on herbivore and carnivore prey

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In trophic interactions, predator effects on prey populations through consumption are often exceeded by non-consumptive effects that predators elicit on prey behaviour. Spiders can elicit strong antipredator behaviour in both insects and other spiders. However, antipredator behaviour has only been investigated in a limited number of insect and spider species. In addition, the mechanisms involved in the detection of predation risk (i.e., predator presence) have rarely been explored in terrestrial systems. We will investigate the occurrence and strength of antipredator behaviour across 18 spider and 18 insect species covering a wide taxonomic range. We are performing behavioural arena experiments in which individuals may choose between filter papers with and without spider cues. In addition, activity of potential prey (time spent immobile, distance moved and velocity etc.) in absence and presence of such cues will be analysed using video records. The selection of study species will allow testing effects of life-history traits on the magnitude of antipredator behaviour. Traits include hunting mode of the predator, relative body size of predator and prey, trophic level, niche width and dispersal ability of the prey. Our study will provide an overview of the commonness and importance of non-consumptive effects among terrestrial arthropods.

C4-P3: Analyzing a trophic system in a Mediterranean plantation using isotopes C and N

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Trophobiosis is considered as a very important ecological factor for ants, at least in temperate and Mediterranean climates. Many ant species are known to feed mostly on honeydew released by aphids. However, little is known about the nutrient fluxes between ants and aphids in the Mediterranean region and the relative importance of trophobiosis for functional diversity of ants. Aim of our investigation is the classification of ants into functional groups based on their diet. Analysis of stable carbon and nitrogen isotopes is a useful tool for assessing the trophic position of animals in food webs. However, there is still a lack of studies combining direct observation between the trophobiotic partners with d^{13}Cand d^{15}N analysis of ants and their potential food sources. Here, we monitored aphid-colonies in both fertilized and non-fertilized areas of a Mediterranean Citrus-plantation and recorded the trophic contact between aphids and ants. The organic fertilizer that is being used at the plantation functions as a labelling in this tritrophic system. For all components of this tritrophic system (soil, host-plant, aphid-ant) we measured the d^{13}Cand d^{15}N signatures. The results showed an unexpected d^{15}N enrichment from aphids to ants, indicating the relative importance of additional nitrogen sources. This indicates clearly that trophobiosis plays a minor role for the ants in the studied ecosystem. Ongoing work will therefore focus on other potential food resources.

C4-P4: Interspecific competition in a specialized aphid community

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Interspecific competition is considered to be one of the most important factors for the structure of ecological communities, but evidence for herbivorous insects is ambiguous. Competitive interactions may also be mediated by third partners, e.g. in the case of apparent competition mediated by a common natural enemy. Less well-studied is the role of mutualistic partners alleviating competition. We studied competitive interactions in a community of three aphids specialized on the same host plant, tansy (*Tanacetum vulgare*), in factorial manipulations of the presence of aphid species on the plant and the presence of ants and natural enemies. Two species feed on the tip of shoots, one of which, *Metopeurum fuscoviride* (ME), is tended by ants, the other one, *Macrosiphoniella tanacetaria* (MA), is not. Ant presence decreased MA survival drastically while ME population growth was very slow without ants. MA had a substantial negative effect on ME populations in the absence of ants. The third species, *Uroleucon tanaceti* (UR), feeds on the underside of leaves and was little affected by the presence of other species yet it negatively affected the growth of the other species. In the presence of natural enemies, the positive effect of ants on ME was increased but aphid survival was generally strongly decreased. UR benefit indirectly from the presence of ME on the plant because of ant attraction that decreased the risk of predation. Our results show that mutualistic partners and natural enemies affect the outcome of competition between the different aphid species.

D1 Spatial dynamics in metacommunities

Oral Presentations

D1-O1: Linking plant functional traits and metacommunity dynamics

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Habitat loss and fragmentation are major threats for biodiversity in agricultural landscapes. Understanding and predicting the response of species-rich communities to landscape fragmentation is a key issue in community and conservation ecology. Such understanding can be augmented by predictive models that capture the key processes of population dynamics in fragmented landscapes and which can be fitted to empirical data of specific communities.

Metapopulation models have been successfully applied to predict the response of single species to habitat loss and fragmentation, but an extension of this modelling approach to whole communities still remains a challenge. One promising approach to tackle this problem is provided by the use of functional groups to represent the complexity of species-rich communities.

We quantified diversity patterns, plant functional traits and species distributions in the Southern Judean Lowlands, Israel. This landscape consists of discrete natural habitat patches with species-rich vegetation embedded in an agricultural matrix.

We first used cluster analysis to classify 70 plant species into functional groups based on 6 plant functional traits. Then we fitted an extended version of the Incidence-Function-Model for each plant functional group using Baysian inference methods. Our model explicitly considers patch shape and area for the derivation of landscape connectivity and colonization rates.

Using different sets of traits for the definition of plant functional groups, we identify plant functional trait syndromes that are most closely related to the response of species to landscape fragmentation. In this way our approach provides understanding of the link between plant functional traits and metapopulation dynamics, as well as a model for predicting the effects of further habitat loss and fragmentation on the plant metacommunity.

D1-O2: Landscape and local effects on butterfly communities in calcareous grasslands

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Habitat size and isolation are considered important drivers for the persistence of insects in fragmented landscapes. In contrast, habitat quality and the composition of the landscape matrix have received less attention. To investigate the effects of habitat area, functional connectivity, landscape context, and habitat quality, we analyzed species richness, density and composition of butterfly communities in pre-alpine calcareous grasslands. Through standardized transect walks in meadows (N = 26), pastures (N = 12), and recently abandoned grasslands (N = 8) we sampled butterflies and burnet moths, as well as environmental parameters. Habitat specialists had higher species numbers if the habitat patches were surrounded by forests instead of non-habitat grasslands. Furthermore, the number of host plants had a positive influence on butterfly diversity and density. Habitat generalists were not affected by any of the landscape variables, but had higher species numbers and densities if the abundance of nectar plants was higher. Nectar and butterfly abundance were correlated both spatially and temporally and varied between the land-use types. Species richness and densities were slightly higher for meadows than for pastures and abandoned grasslands. On the species level, some species showed preferences for certain land-use types. In contrast to other studies, we showed that the impact of habitat quality on butterfly communities is more important than landscape effects. The proportion and connectivity of calcareous grassland in our study region seemed to be generally too high to observe fragmentation effects. Contrary to expectations, surrounding forest increased the viability of habitat specialists in the habitat patch, possibly by sheltering from wind and eutrophication, or by preventing dispersal into sink habitats.

D1-O3: Coevolution of dispersal in interacting metacommunities

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Despite empirical evidence suggesting that interspecific interactions influence dispersal of organisms, the evolution of dispersal strategies in the species forming metacommunities has rarely been studied. To investigate this issue, we develop an individual-based model of a metacommunity, where guest species depend on hosts as critical resources and local population dynamics are governed by a (stochastic) Nicholson-Bailey type interactions. Our results demonstrate that – in comparison to a neutral system (commensalism) – parasitism promotes the evolution of dispersal in both, hosts and parasites, while mutualism tends to reduce dispersal rate of both partners. Hosts always evolve higher dispersal due to the asymmetry in the ability to colonize empty habitat sites. External extinction, dispersal mortality, and searching efficiency (only in the case of parasitism) influence the evolution of dispersal in metacommunities. Moreover, when a 2 hosts - 2 guests system is compared with 1 host - 1 guest system, lower dispersal rates evolve in more specious systems.

D1-O4: A theory of resource competition on spatial gradients

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Resource competition is a fundamental interaction in natural communities. However, little is known about competition in spatial environments where organisms are able to regulate distributions. In this presentation we develop a general framework for analyzing the competition of two consumers for two limiting resources in a one-dimensional habitat in which the resources are supplied from opposite sides; a setting that is typical for many systems such as water columns, sediments or interfaces between different environments.

In extension of the R*-rule for uniform systems, we introduce the notion of an invasion threshold as the maximal resource requirement for a consumer to invade in the presence of a resident species. In this way, the outcome of competition can be interpreted graphically in the resource plane, by comparing the location of the invader's critical resources with respect to the invasion threshold lines. We derive analytic expressions for the invasibility conditions and show that they can be related to how resources are spatially reduced as a result of resource-use by the resident.

Our analysis reveals that parameter combinations which lead to coexistence in a uniform environment may favour alternative stable states in a spatial system, and *vice versa*. Furthermore, differences in growth rate, mortality or dispersal abilities allow a consumer to coexist stationarily with - or even outcompete - a competitor with lower resource requirements.

Applying our theory to a phytoplankton model, we explain shifts in the community structure that are induced by environmental changes.

D1-O5: Spatio-temporal turnover of a phytoplankton metacommunity in the Wadden Sea

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Communities are structured by interacting processes operating at both local and regional scales, as described in the metacommunity concept. However, the applicability of this concept to pelagic assemblages, which are often considered as homogeneous, has not been tested yet. Therefore we examined changes in the phytoplankton community as well as in corresponding environmental variables horizontally between sampling sites and vertically with depth in a highly dynamic, open system (Wadden Sea, North Sea, Germany) throughout 2009. Sampling was conducted in a biweekly rhythm around half tide in three different depths at three stations located along a current velocity gradient. In consequence of the strong temporal turnover, which is coupled with different abiotic conditions (most influential variables were phosphorus and temperature), Bray-Curtis species dissimilarity is positive correlated with time. Dinoflagellates prevailed during summer whereas a spring and an autumn diatom bloom, dominated by the invasive species *Mediopyxis helysia*, was observed. Severe hydrodynamic forces promote a strong bentho-pelagic coupling, resulting in a low vertical beta-diversity especially in spring and autumn. Despite its apparent homogeneity, the ocean offers a heterogeneous environment to its residents in time and space.

D1-O6: Resilience and diversity patterns of aquatic metacommunities

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The diversity – stability debate is a long-standing issue in ecology, asking whether more diverse communities show higher stability over time and more rapid recovery from disturbance. Recent studies showed that disentangling the mechanisms for local and regional diversity requires the analysis of spatial and temporal dynamics embedded in a metacommunity framework. Here we tested the relationship between dispersal, disturbance, and stability using an experimental marine phytoplankton metacommunity. Our metacommunities consisted of three connected microcosms (local patches), which were connected by tubes allowing for different dispersal rates by manipulating openness of the tubes. Each patch was inoculated by the same 15 marine phytoplankton species isolated from the same habitat. Disturbance was applied on either patch or metacommunity level, by either removing 75% of the algal biomass in one randomly chosen local patch or 25 % or 75% of the algal biomass in all patches of the metacommunity. Additionally, in the second experiment, we established a heterogeneous environment by manipulating the light intensity (low, medium, high) for each patch within one metacommunity - set up. Resilience was measured by comparing recovery of biomass after disturbance to the undisturbed control. We found that both the scaling of disturbance and dispersal rate affected resilience, which was further related to diversity. Furthermore, we show that an environmental gradient enhances species diversity, can be understood from the perspective of species sorting. Spatial dynamics contribute to the recovery of communities from disturbance and affect diversity – stability relationships.

D1-O7: Biodiversity-productivity relationships in metacommunities

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Recent models and concepts suggest that resource ratios are the key to understand the relationship between biodiversity and primary production. We tested this concept in two microcosm experiments with pelagic model metacommunities. The metacommunities received different P-supply, the patches differed in N:P ratios. In the first experiment, a phytoplankton

assemblage was inoculated with or without ciliate consumers. At the level of the entire metacommunity, we found strong increases in biomass and decreases in species richness and evenness with increasing P-supply. Without consumers, increasing resource use efficiency (RUE, realized biomass per unit P) was found with increasing richness and evenness. At the patch level, evenness increased realized productivity only at imbalanced N:P (2 or 128) but not at balanced N:P. In the second experiment, we again found increases in biomass and decreases in evenness with increasing P and a positive correlation between regional evenness and RUE. When we compared the phytoplankton assemblage to the component monocultures, the mixtures were not always outperforming the single species, but we found significant overyielding at highest P-supply. In conclusion, P-supply drives absolute productivity and affects diversity, whereas resource stoichiometry constrains the relationship between biodiversity and RUE.

Poster Presentations

D1-P1: Resource use efficiency and diversity of aquatic metacommunity

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The spatial dynamics of organisms and abiotic factors is an ongoing challenge in ecology, asking which effects dispersal of abiotic factors (e.g. nutrients) and/or organisms has on the shaping of communities. In the last decades researcher used the approach of metacommunity framework to investigate how disturbance (e.g. biomass loss, predation) and dispersal affect community diversity and stability patterns at different spatial scales. However, we lack information whether communities might also be influenced by dispersal of abiotic factors. Only a few studies investigated the idea of "Metaecology" using the theoretical concept of metacommunities.

Here we tested the relationship between dispersal of organisms and nutrients using experimental marine phytoplankton. A metacommunity consisted of five microcosms (patches) connected by tubes allowing for dispersal. Rates of dispersal were manipulated by opening the connecting tubes. Each patch was inoculated by the same six marine phytoplankton taxa. To achieve a gradient of nutrient dispersal (nitrogen and phosphorus) we enriched only the two outer patches with nitrogen and phosphorus, respectively. In the other treatment without a gradient of nutrients, each patch was enriched with one-fifth of the entire available concentration of nitrogen and phosphorus. We estimated different diversity indices (species evenness and species richness) as well as resource use efficiency. Nutrient dispersal affected evenness rather than species richness. Spatial dynamics of nutrients is not a negligible factor and contribute to the shaping of communities and consequently affect diversity patterns.

D1-P2: Life history traits influence resilience in a virtual reef system

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Coral reefs are highly productive but also fragile ecosystems that provide habitats for coastal fauna and multiple services to local communities. Yet, conditions of many coral reefs changed dramatically within the last few decades and reports of phase shifts from once coral dominated systems to algal dominance are numerous from all around the world. While the consequences are similar, the causes and involved processes in the course of a phase shift can be diverse. Hence, improving the understanding of resilience – which, in a coral reef is influenced by species diversity, life history of reef participants, and functional redundancy of ecosystem services, among others – should be one central point in future reef studies.

In the presented work we utilize an individual based model of a virtual coral reef system with focus on spatial competition of selected benthic organisms to analyse the influence of specific life history traits on reef recovery after disturbance events. We defined several functional types of scleractinian corals with different life history properties in terms of reproduction, morphology, growth rate, and mortality. These corals compete with each other and also with algae under different environmental settings. In simulations various parameters, which are believed to be important for reef resilience, can be tested within their known ranges. A subsequent evaluation of respective outcomes can improve the general understanding of reef functioning and may aid the decision of which management measures to apply for particular coral reef systems.

D2 Towards rules of thumb for predictions of range dynamics

Oral Presentations

D2-O1: To move or not to move: Rethinking range shifts as responses to climate change

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The view that ongoing climate change is unprecedentedly fast has fuelled the prediction that it will also have unprecedented effects on Earth's biodiversity. However, new geophysical research suggests that dramatic climatic changes during the Late Pleistocene occurred extremely rapidly over just a few years. These abrupt changes might have been even faster than contemporary ones, but relatively few continent-wide extinctions of species were documented for these periods. This raises questions about the importance of range shift dispersal (the movement of species distributions across large geographic distances) as predominant response of species to cope with climate change. Here, we argue that species' ability to survive drastic climate change may be greater than hitherto recognised, perhaps due to the phenotypic variability of populations, or to their ability to survive in microclimatic pockets in a heterogeneous landscape. In other words, species are probably more resilient to climatic changes than anticipated in most model assessments of the effect of contemporary climate change on biodiversity. However, we also stress that the synergetic effects between climate change and the ongoing destruction and fragmentation of natural habitats (leaving aside further anthropogenic pressures for biodiversity) should by no means be underestimated.

D2-O2: Feedbacks and hysteresis in plant range dynamics

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Changes in plant distributions as a consequence of global changes will follow predictable patterns to an unknown extent. In order to usefully model such changes, we thus need to predict the predictable patterns as well as evaluate how predictable they really are. Low predictability can be expected especially for range margins that coincide with vegetation boundaries, such as arctic and alpine treelines, desert margins, or savannah-forest ecotones, that are stabilized by positive feedbacks. Such feedbacks can retard change, but they can also accelerate change once threshold conditions have been reached or after disturbance. The behaviour or such boundaries is still incompletely understood and requires a mechanistic

approach. Based on case studies and theoretical considerations, the importance of feedbacks and the possibilities for incorporating these into species- and ecosystem-level range dynamics models will be discussed.

D2-O3: The climate niche of a mountain carabid: consequences under climate change

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Species constrained to mountains are considered to be highly susceptible to climate change. Their restriction to high altitudes has often caused disjunct distributions and intraspecific differentiations. Up to now, patterns of disjunct distributions have rarely been taken into account for climate envelope modelling. The aim of this study was to investigate whether a region-specific modelling approach leads to more realistic predictions of future ranges under climate change.

We applied a climate envelope model on an intraspecific scale to analyze the cold-adapted ground beetle *Carabus sylvestris* (Coleoptera: Carabidae), showing a disjunct distribution in Central and Eastern European mountain systems. We split the species' range into three geographic groups and modelled (1) low mountain range populations in Central Europe, populations in (2) the Alps and (3) the Carpathians individually to investigate intraspecific climate niche characteristics and their implications assuming two emission scenarios for 2050 and 2080. We compared these models with one for (4) the entire species' range.

Our findings indicate an intraspecific climate niche variability and serious range contractions for the considered regions. The potential distribution of (1) low mountain range populations will shift almost entirely to higher altitudes of inaccessible high mountains. Suitable habitats for populations in (2) the Alps will disappear by 2080 under scenario A2a. (3) Carpathian populations will lose all favourable areas by 2050, independent of the applied scenario. However, model results for (4) the entire range do not illustrate region-specific implications of altering conditions and thus underestimate the impact of a changing climate.

Hence, the whole species is prone to climate change, which would not have been revealed without the applied scale of modelling. We conclude that an intraspecific modelling scale might foster more realistic predictions for disjunctively distributed species.

D2-O4: Does climate change necessarily disrupt biotic interactions?

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Climate change is expected to alter biotic interactions leading to temporal and spatial mismatches of interacting species. Especially, species with essential partners may suffer from spatial or temporal de-synchronisation. However, the implementation of biotic interactions in species distribution modelling is rarely taken into account and poses some challenges.

Here, we examined potential impacts of climate change on the biotic interaction between three butterfly species (*Gortyna borelii sp. lunata, Maculinea nausithous* and *Maculinea teleius*) and their feeding plants (*Peucedanun officinale* and *Sanguisorba officinalis*) in Europe using an ensemble forecasting modelling technique (BIOMOD). We applied two different approaches of considering these biotic interactions in species distribution modelling: (1) an 'explanatory variable approach', modelling the potential future distribution of the butterfly with the projected current and future occurrence probability of the plant as additional explanatory variable beside climate, and (2) a 'reference area approach' modelling the current distribution of the butterfly in the current range of the plant (model fitting) and projecting its potential future occurrence probability on Europe.

According to the models, the biotic interaction between the butterflies and their respective host plants tends to remain stable. The approaches differ in their predictive performance related to the AUC and in their span width concerning the projected range change between the different modelling algorithms.

Climate change does not necessarily lead to future spatial mismatches between interacting species. Nevertheless, the temporal scale, which means in this case the provision of food resources at the time of reproduction, is not considered. For this reason, a temporal mismatch can occur beside spatial congruence.

D2-O5: Altitude affects adaptation strategies of alpine butterfly species

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Many studies concerning biodiversity patterns along altitudinal gradients were conducted in the tropics, but comparable data for temperate zones are rare. We investigated species richness-altitude patterns and different adaptation strategies of butterfly and diurnal moth species inhabiting extreme environments in the Alps. Surveys were conducted at 34 sites in the National Park Berchtesgaden and its surroundings in the southeast of Germany. We sampled butterfly and diurnal moth species in transect walks along an altitudinal gradient and analysed elevational richness patterns. To understand how butterfly species adapt to alpine ecosystems we analysed the prevalence of different life-history traits in relation to altitude. We found a linear decline with altitude for butterfly and diurnal moth species richness. Egg number was higher for butterfly species occurring at higher altitudes and egg maturation time was shorter. Butterfly species inhabiting alpine meadows showed no differences in number of generations per year compared to butterfly species living in the lowlands. Altitude was a major predictor for biodiversity patterns. Our data indicate butterfly species compensate the shorter vegetation time in higher altitudes by laying more eggs and having a shorter egg maturation time. In the face of climate change it is very important to comprehend the mechanisms that determine species richness and to take adaptation strategies into account for enhanced conservation measures.

D2-O6: Predicting climate-induced range dynamics of black grouse in Switzerland

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In recent years, it has often been suggested to supplement empirical species distribution models (SDMs) with more mechanistic approaches to make more realistic predictions of environmental change-induced range changes and associated extinction risks. On the other hand, with model complexity also the variability in predictions may increase. Here, we linked SDM predictions of habitat suitability to a spatially explicit, individual-based model to study range dynamics of black grouse (*Tetrao tetrix*) in the Swiss Alps. We quantified uncertainty in various model outputs arising from different SDM algorithms, different climate scenarios and population model parameters. Potentially suitable habitats for black grouse were predicted to shift uphill and eastward over the 21st century. Predictions of population dynamics were highly variable across simulations and indicated a negative population trend at present. Results underscore that extinction probabilities cannot be inferred simply from quantity of suitable habitat but depend on the complex interplay between life history traits and habitat. In dynamic range predictions, uncertainty in SDM algorithms and climate scenarios can become secondary to demographic model components. Overall, our results support a general movement away from purely correlative to dynamic range predictions. However, this must be accompanied by explicit robustness analysis and more research is needed to determine reasonable error margins for demographic parameters that can be expected under environmental change. A more direct benefit of such integrated models is an improved mechanistic understanding of dynamic species' responses to environmental change.

D2-O7: Why we need demographic knowledge to understand and forecast range dynamics

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The dynamic nature of species ranges causes mismatches between a species' distribution and the set of suitable environments in which populations can persist (the Hutchinsonian niche). For instance, source-sink dynamics cause species to occupy unsuitable environments outside their Hutchinsonian niche. Moreover, species in disequilibrium with their environment may be absent from suitable environments (because of migration limitation) or present in nowadays unsuitable environments (because of time-delayed extinction). Since correlative species distribution models do not account for these spatial dynamics, their estimates of species niches and their forecasts of range dynamics are likely to be biased.

Recently developed Dynamic Range Models (DRMs) overcome this problem through the joint statistical estimation of spatial dynamics and the underlying demographic response functions from species distribution data. DRMs produce process-based estimates of niches, forecast range dynamics under future environmental change, and quantify the uncertainty in these forecasts. This constitutes a qualitative advance in species distribution modelling. Yet, the broad application of DRMs still requires substantial research efforts. We outline the three key elements of this demographic research agenda for dynamic biogeography: i) advances in the statistical modelling of local dynamics and dispersal for a wide range of life history types, ii) the systematic collection of empirical data on temporal dynamics of distribution and abundance and of qualitative and quantitative knowledge on demographic responses to the environment, and iii) improved theoretical understanding of the spatial scaling of demographic rates and the dynamics of spatially coupled populations.

D2-O8: Dispersal abilities affect distributions of interacting species

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Response of species assemblages to environmental change is regulated by species' specific reactions to external abiotic drivers (e.g. environmental conditions, disturbance), but also by biotic mechanism, such as dispersal and interspecific interactions, that define community dynamics. In this study, we analyse the responses of two strongly interacting species to realistic scenarios of change in suitable climatic conditions. The two species are the butterfly *Boloria titania* whose larvae feed predominantly on the herbal plant *Polygonum bistorta.* For these species future projections of species-specific climate suitability exist, from which we parameterise a two species metapopulation-analogous model. This model enables us to evaluate community dynamics under climate-change with different assumptions of dispersal. The results show that dispersal ability of both species is decisive to track climate change but also to avoid spatial segregation. However, host species dispersal in particular limits obligately dependent species, even if climatic conditions and higher dispersal abilities would allow larger range expansions.

D2-O9: Evolution and its consequences for predicting interspecific range shifts

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Climate change compels species to 'react' in some way for the long-term persistence; possible responses are tracking the shifting climatic conditions or adapt to the new conditions, respectively. Several theoretical studies have investigated this problem, but most of these are restricted to single species approaches, i.e consider a single species in isolation. However, many species are presumably constrained in their distribution by interactions with other (competing) species.

Here we present an individual-based simulation model of metapopulations of two species competing for resources along an existing climatic gradient. For both species selection can modify adaptation to local conditions (niche dimension) and emigration probability; dispersal is limited to nearest-neighbour. Without a gradual climatic change a range border between the two species establishes initially in the middle of the world. When imposing a gradual change (increase in mean temperature) we find different responses, depending on the magnitude/speed of environmental change and species' niche width. Actually, only a restricted range of parameters leads to tracking of the range shift predicted from the moving climate envelope. Over a wide range of conditions the interspecific range border moves much slower due to evolutionary adaptation to changing conditions and in some scenarios it may not move at all.

We conclude that evolutionary response has the potential to strongly alter predictions of future distributional shifts in multispecies systems and should not be underestimated in its importance.

Poster Presentations

D2-P1: Are niche-shifts predictable? The case of the Asian tiger mosquito *A. albopictus*

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Species distribution models are increasingly used to predict species' range shifts in space and time based on information about their preferred environmental conditions. So far, the assumption of niche-conservatism is crucial to most modelling techniques and the possibility of niche-shift occurring during the process of invasion is not explicitly taken into account. Hence, current techniques fail to predict distributions of invading species when niche-shift has occurred during invasion. While the causes of apparent niche shifts are not necessarily known, the phenomenon of niche shifts has been documented in several case studies, among these the Asian tiger mosquito *Aedes albopictus* (Skuse 1894).

It has been suggested that the direction of niche-shift in environmental space may be driven by the availability of environmental conditions in the invaded range: If the originally preferred conditions are rare, the species shifts its niche and adopts to conditions that are more common. Using *Aedes albopictus* as a case study, we tested this assumption and provide initial steps towards including the mechanism in species distribution models.

D2-P2: Ecological niche modelling with herbarium data in a Mediterranean context

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The effectiveness of biodiversity conservation strategies depend on the knowledge about the distribution of habitats or single species, but efforts on biodiversity monitoring and conservation are currently hindered by a lack of basic information about the spatial distribution of species on large landscapes. In the last decades, with the growing availability of digitized spatial data and the need of solving this ecological problem, species distribution models received growing interest from conservation biologists. The vast majority of data available for modelling plants distribution are herbarium records, and, although it has been found that herbarium records provide limited accuracy in predicting distribution, they remain the only available source with regard to relevant and ample distribution data. Therefore, modifying existing statistical tools and developing new methods so that herbarium data, despite their shortcomings, can be used for modelling habitat suitability, is currently a growing field. This work focuses on defining the opportunities and bottlenecks for future application of distribution models in the mapping and monitoring of Natura2000 habitats as these models could represent a straightforward but robust tool to improve the monitoring of Natura2000 habitats. Here we specifically concentrate on testing the maximum entropy (Maxent) approach to estimate the distribution of a training habitat through the use of herbarium records. Through GIS overlay operations of the Maxent' outputs for each species characterizing the habitat investigated, we obtained a distribution map of the Natura2000 habitat. However, the modelling approach followed by this study, taking into account the uncertainty proper of the ecosystems, could represent a useful tool for conservation and management since it can aid in the process of focusing conservation action into the right geographical locations and in ranking areas in terms of conservation values.

D3 Analysis of spatial and temporal patterns in diversity of forest ecosystems

Oral Presentations

D3-O1: The ERC project SPATIODIVERSITY towards a unified spatial theory of biodiversity

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One of the biggest and most persistent challenges in contemporary ecology is to explain the high diversity in ecological communities such as tropical forests, grasslands, coral reefs, or plankton ecosystems. The broad objective of our project is to understand the relative importance of processes and factors that govern the composition and dynamics of species-rich communities. Advances in this issue have important implications for efforts to protect terrestrial biodiversity from climate and land use change. Surprisingly, although most processes which are thought to contribute to species coexistence have a strong spatial component, the rich source of information on spatial patterns has not been used. To accomplish our goal, we take a radically different approach than previous attempts and adopt a spatially explicit perspective that will allow us to take significant steps towards a *Unified Spatial Theory of Biodiversity*. We use the best data sets available, i.e., 25-50 ha mega-plots of tropical forests each comprising several hundred of species and >100000 trees that are monitored and censuses every 5 years. We proceed in three steps. (1) We quantify the highly complex spatial structures found in these forests using state-of-the-art techniques in spatial pattern analysis. (2) We build a range of individual-based spatially-explicit simulation models ranging from "pure" neutral models to detailed process-based models of tropical forest, such as FORMIND. (3) We use pattern-oriented modelling to confront these simulation models with the set of patterns identified in (1) to identify the most parsimonious models that account simultaneously for all (spatial) patterns. We anticipate that the new spatial perspective and innovative computer modelling techniques will allow for a major breakthrough in this important challenge at the frontier of ecological research, and open up new horizons for understanding and conservation of biodiversity.

D3-O2: Modelling the dynamics of tropical forests - state of the art and perspectives

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Tropical rain forests cover roughly 12 % of the earth's land surface, but are habitat for more than a half of the species of the world. Logging of timber, land clearing and ongoing fragmentation are threatening tropical rain forests. Understanding the dynamics of disturbed and undisturbed tropical rain forests is an important issue for conservation and adapted management of these forests.

In this contribution we will present a review on forest models for tropical rain forests. On one hand we will discuss largely simplified models like the neutral models (Hubbell approach) for describing the dynamics of tree species. On the other hand we will discuss the role of process and individual-based rain forest models to analyse the structure and dynamics of these species rich forests. Process-based models e.g. allow the calculation of detailed carbon balances and fluxes. Typical results of different model types will be shown. Key ecological results, limitations and future perspectives will be discussed.

D3-O3: Spatiotemporal changes in species associations among recruits in a wet tropical forest

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Many of the mechanisms allowing coexistence of hundreds of species in wet tropical forests are most likely to take place during the seedling stage. They may be classified into those related to heterospecific interactions between seedlings, governed by the differential performance of species across gradients of abiotic resources (niche partitioning), and those related to conspecific interactions, mediated by stochastic processes such as seed dispersal and limitation, that suggest that coexisting species are ecologically equivalent (ecological equivalence). Whether each of these mechanisms explains coexistence of species they should leave an imprint in the spatial patterns of seedling communities in these ecosystems. We studied pair-wise species associations between 64 species of trees and shrubs at the seedling stage during five census intervals and at three spatial scales (r = 3, 15 and 30 m) in Barro Colorado Island Forest Dynamic Plot (BCI, Panama). We used the two-axes classification scheme of Wiegand et al. (2007) “Species associations in a heterogeneous Sri Lankan dipterocarp forest”. We analyzed if these associations were determined by number of individuals, characteristics of univariate spatial patterns, plant traits (i.e. growth-form guild, shade-tolerance index, maximum sapling growth, reproductive size, seed dry size and dispersal mode), and phylogenetic relatedness of the species involved, by performing Multivariate Regression Trees. Our results suggest that Negative Density Dependence mediated by abundance of species is the dominant process allowing coexistence of species in BCI. This process, however, is affected by others whose strength varies through spatial scales. Niche partitioning associated with shade-tolerance index of species may occur up to 3 m from the focal species (particularly after El Niño events), and seed limitation associated with differential dispersal modes dominates from 15 m onwards.

D3-O4: Tropical tree species assemblages change in time and with life stage

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Recent studies have documented shifts in habitat associations of single tropical tree species from one life stage to the next. However, the community level consequences of such shifts have not been investigated, and it is not clear if they would amplify, neutralize, or completely alter habitat structuring during the transitions to the adult community. We compared habitat-driven species assemblages at three life stages (i.e., recruit, juvenile and reproductive stages) and six censuses for tree and shrub species in a fully censused 50-ha plot of Panamanian lowland forest. Habitat types were determined using multivariate regression trees that group areas with similar species composition (i.e., species assemblages) according to their topographic characteristics. Three topographic variables were major determinants of species assemblages. When analyzing individuals of all life stages together, we found a distinct and temporally consistent structuring of the plot into four dominant habitat types that was consistent with previous classifications. Basically the same habitat structuring emerged for the juvenile communities of individual censuses. However, recruits showed a weak and temporally inconsistent habitat structuring. A notable homogenization in species assemblages occurred during the transition from juvenile to reproductive, through both a reduction in the number of species assemblages and a reduction of the classification error. Overall, habitat structuring became noisier and weaker over the 25 years of the study. Our results suggest that mortality processes during the transition from recruits to juveniles must enhance the signal of habitat structuring. However, during the transition to reproductive, species may have lost the advantage of being in the habitat with which they had become associated, or the quality of habitat changed during their lifespan due to larger climatic changes. The homogeneous assemblages of the reproductive stage could be interpreted as support for neutral theories, but further research is required to unravel the mechanisms behind these intriguing observations.

D3-O5: Tropical tree species assemblages in topographic habitats for different cohorts

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Habitat-driven species assemblages and species distribution patterns in recruits, juveniles (< 1cm dbh), and adults (>=1 cm) were examined for 219 species in the 25-ha Dipterocarp forest in Sinharaja (Sri Lanka). Habitat types[1] were determined with Multivariate Regression Trees that grouped areas with similar species composition (i.e., species assemblages) according to the topographic variables elevation*,* aspect*,* slope*,* altitude above channel (ACH)*,* topographic

wetness index (TWI), and convexity. The variance explained by topographic variables for different life stages ranged between 13 and 24%. *Elevation* explains most of the species variance (10-13%), and convexity and slope were least important for the habitat classification. However, in contrast to earlier studies in the Sinharaja forest, aspect played an important role in our habitat classification. We found that the species assemblages emerging for the juvenile stage were the same as for the adult stage and similar to that for recruits. Habitat change due to temporal variation was negligible in all life stages. In Sinharaja, the indicator species for the juvenile stage were also indicators in the adult stage. Most species in the juvenile stage were associated with steep spurs but less steep spurs hosted more species for adults; which is similar to results from the Gutian Plot (China). Unconstrained K- means cluster analysis explained approximately 41-62% of species variance in the different life stages. This additional variance occurs due to important unobservable variables.

[1]Steep spurs, S-W less steep spurs, S-W of the valley, N-E less steep spurs with Low-ACH, N-E less steep spurs with high-ACH

D3-O6: Light dependence of growth and mortality in a Sri Lankan tropical rain forest

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Light is one of the most important resources for trees in tropical forests. Unfortunately, however, direct light measurements are usually not only subject to considerable measurement uncertainty, but also difficult to obtain for larger plots because of the large number of measurements that would be necessary to cover all three dimensions with sufficient resolution. The problem with this missing information is that any analysis of individual species traits is potentially confounded by the unknown light conditions. For example, one may be uncertain whether a species shows high growth rates because it grows fast per se, or because it typically occurs in good light conditions.

Here, we use generic allometric relationships for tree height and crown sizes to generate a three-dimensional light climate reconstruction from known locations and diameters of the ca. 200,000 trees on the Sinharaja 50 ha forest dynamics plot in Sri Lanka. Using this light climate reconstruction, we examine light climate associations for the approximately 200 tree species on the plot. As hypothesized, we find that species that are generally know as pioneer species are more likely to be found in higher light conditions. This is not surprising, but suggests that our light climate reconstruction is reasonably accurate to be used for further analysis. Subsequently, we use the reconstructed light climate to examine the species- and size-specific dependence of growth and mortality on light for the most common trees on the plot. We conclude that the applied method of light climate reconstruction may be useful for including light as a covariate in statistical analysis and for grouping of species according to their typical light associations.

D3-O7: Testing the independent species arrangement assertion of biodiversity theories

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The assertion that the spatial location of different species is completely unrelated to each other is fundamental in major ecological theories such as neutral theory that describe a stochastic geometry of biodiversity. However, this assertion has rarely been tested. Here we use techniques of spatial point pattern analysis to conduct for the first time a comprehensive test of the independence assertion by analyzing data from three forest megaplots with different species richness, a species rich tropical forest at Barro Colorado Island (Panama), a tropical forest in Sinharaja (Sri Lanka), and a temperate forest in Changbai (China). We hypothesize that stochastic dilution effects due to increasing species richness overpower signals of species interactions, thereby producing an appearance of independence. Indeed, the proportion of species pairs showing (i) no significant interspecific association increased with species richness, (ii) segregation decreased with species richness, and (iii) the importance of small-scale interspecific interaction decreased with species richness. This suggests that independence may be indeed a good approximation in the limit of very species rich communities. Our findings constitute a major advancement in the understanding of factors governing species rich communities because they explain why species placement in species rich communities cannot be distinguished from independence.

D3-O8: Tree distribution determined by habitat heterogeneity and dispersal limitation

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Understanding processes underlying spatial distribution of tree species is fundamental to studying species coexistence and diversity. This study modelled point patterns of tree distribution, expressed by Cartesian coordinates of individual trees within a mapped forest stand, for the purpose of identifying processes that may generate spatial patterns of tree communities. We used four primary point pattern processes (homogeneous Poisson process, inhomogeneous Poisson process, homogeneous Thomas, and inhomogeneous Thomas process) to model tree distribution in two stem-mapped forests in Taiwan, Republic of China. These four models simulate spatial processes of habitat association and seed dispersal, allowing us to evaluate potentially the contribution of habitat heterogeneity and dispersal limitation to the formation of spatial patterns of tree species. The results showed that inhomogeneous Thomas processes was the best fit model and described most of the species studied, suggesting that spatial patterns of tree species might be formed by the joint effects of habitat associations and dispersal limitation. Homogeneous Thomas process that models the effect of dispersal limitation was the second best model. We also found that the best fit models could be predicted by species attributes, including species abundance and dispersal model. The

significant traits, however, were differed between the two study plots and demonstrated site-specific patterns. This study indicated the interactive operation of niche-based (habitat heterogeneity) and neutral-based (dispersal limitation) may be important in generating spatial patterns of tree species in forest communities.

D3-O9: Point pattern analysis of highly fragmented forest stands in Northern Brazil

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The study site is located within the Marine Extractivist Reserve (RESEX) Caeté-Taperaçu, in Pará, Brazil. The RESEX hosts several forest fragments varying in size from 1 to 33 ha on terra firme that are remnants of barrier islands in the estuary of the river Caeté, today surrounded by frequently inundated mangrove forests and marshes. These fragments show an unusually high diversity and well-developed forest structure in comparison to other woody restinga vegetation of northern Brazil. The study investigated two of these fragments, tackling the following research questions: (1) How does the stand size influence the structure and spatial distribution of tree species? (2) Does the distance between the forest stands determine similarities in species composition? and (3) Is there evidence of change in vegetation structure caused by human impact? The particularity of the approach consists in the application of point pattern analysis (PPA), based on a tree position inventory (n = 1029) of three patches within the terra firme fragments. The talk will focus on two main points. On the one side, the results of the study will be presented. On the other side, the field method itself shall be discussed. To gain the required data sets for PPA of forests - which is the x,y-position of each tree of interest - causes a major problem, since time for field data collection is often restricted, and the utility of GPS is limited under the forest canopy. The applied method relies on simple devices (tape, compass, laser rangefinder) and can be easily reproduced.

D3-O10: Tree diversity patterns of igapó forests across the Rio Negro, Central Amazonia

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In Central Amazonia the major igapó forests are flooded annually by nutrient-poor blackwater of the Rio Negro. These flooding events have a strong impact on plant communities whose species composition and diversity patterns are continuously changing not only temporally but also spatially along the river channel. The majority of floodplain research has concentrated on whitewater *várzea* forests while *igapó* have scarcely been inventoried. Our research questions are: 1) is species richness and diversity in the igapó forest lower or higher than that observed in várzea forests2) is species diversity in igapó forest constant along the river course or are there longitudinal gradients? and 3) what is the degree of species similarity (or dissimilarity) between the igapó of the Rio Negro and other Amazonian floodplain forests? We conducted botanical inventories in 10 ha plots (160 x 625m^2) in late-successional igapó forests along the upper, middle and lower sections of the Negro river. Overall, we registered 6126 individuals from 244 species distributed in 136 genera and 51 families. We found an average of 63 sp/ha classifying this forest as one of the poorest forest types in the Neotropics and comparable with its whitewater counterpart is by far the poorest inundation forests in the Amazon. Our results suggest little variation in species richness along the course of the river but a strong variation in terms of species turnover. The species registered in igapó forests occur more in surrounding non-flooded forest types than in its whitewater counterpart. In fact, only 34% of the species identified in igapó forests along the Rio Negrooccurin várzea while the remaining species occur in terra firme, white-sand forests or wet savannas. This work forms the basis for further studies to be carried out to analyze the relationship between igapó forests, the flooding regime and edaphic gradients across the river channel. The results will contribute to the understanding of species distribution, adaptation and colonization strategies in response to predicted changes of flooding frequency due to climate change in the Amazon.

D3-O11: Topography effects on herbivory and decomposition in a tropical montane forest

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Stature, productivity and species composition of tropical montane forests can vary greatly from ravines to adjacent ridges, but this small-scale heterogeneity is not well understood.

We studied foliage and litter quality, foliar litter productivity, herbivory and leaf litter decomposition in upper slope (USF) vs. lower slope forest (LSF) in a tropical montane forest in Ecuador with contrasting stand structure and edaphic conditions.

LSF exceeded USF in litter production and several measures of foliage and litter quality (e.g. leaf toughness, nitrogen concentration). In both relative and absolute terms herbivory was higher in the more productive forest type, LSF. A litter bag experiment showed that LSF leaf litter decomposed significantly faster than USF litter, whereas the site of decomposition did not affect decomposition significantly.

Our results suggest that the stunted stature and distinct floristic composition of upper slope forest is maintained by a feedback cycle of low soil nutrient availability, low foliage quality and poor mineralisation.

D3-O12: Patterns and shifts in birds along complete altitudinal rainforest gradient

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Monitoring of species response to climate change is currently highly relevant as climatic change on biotic communities is usually associated with changes in the distribution of species. Therefore, the elevational gradients can serve as a heuristic tool responding to new demand for biodiversity data from a range of altitudes.

We explored the distribution of bird diversity along complete rainforest altitudinal gradient from the lowland floodplains of Ramu River (200m a.s.l.) to the timberline (3700m a.s.l.) on the slopes of Mt Wilhelm, the highest peak of Papua New Guinea. The study was completed at eight stations evenly spaced at 500m altitudinal increment. Each elevation was surveyed by point count method, mist-netting and MacKinnon list technique. By using simple logistic regression, we compared recent and historical (until 1984) presences or absence of species in studied elevations.

We made a total of 22678 individual observations comprising of 256 bird species. We document hump-shaped diversity patter with the highest number of species recorded at 700m a.s.l. and minimum of species recorded at 3700m. The two neighbouring elevations in lowlands (200 and 700 m a.s.l.) were the most similar (Jackard = 0.72) and shared 64 species. The mid-elevations were the most different (1700 and 2200 m a.s.l., Jackard = 0.36, 34 shared species). The general upward trend between historical and recent observations is statistically significant [ANOVA, F_1=13.843, p=0.0002]. More than 45% species shifted their presence to higher elevation, whereas only 5.5 % of species was recorded at lower than historical elevation.

D3-O13: Biodiversity and invasion in a Bangladesh forest ecosystem

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Tropical forests are the hot spots of species richness on earth. Various impacts are increasingly harming these ecosystems. Improved knowledge on drivers, patterns and potential of protection attempts for the biodiversity of tropical forests is urgently needed in order to design and adapt management and conservation strategies in face of land use and climate change.

Because of the limited space and high population density, tropical forests in Bangladesh are especially under threat. Land use pressures and recent climate change compromises the conservation of the last (semi-) natural tropical forest ecosystems. We conduct the first spatially explicit analysis of drivers and patterns of biodiversity in terrestrial Bangladesh forests based on multivariate approaches, similarity analysis and variation partitioning. Our aim is to differentiate the influence of soil type, topographic conditions, and disturbance regime as well as nature protection on plant species richness, invasive species richness and heterogeneity patterns.

The study focuses on Satchari Reserved Forest and its vicinity. Plant species richness as well as species composition is strongly related to a disturbance gradient that is in correlated with protection and elevation (despite a small topographic range of 70 m). However, in our analysis both, topography and protection remain significant after correcting for disturbances. Soil characteristics are especially related to species composition, while only moisture has an effect on species richness. Results highlight the importance of disturbance regime, nature reserves and protected areas for biological diversity in Bangladesh. The enforcement of protection legacy and the integration of local communities have to be stressed.

D3-O14: Climate forcing lets oak outperform beech on dry and wet sites in NE-Germany?

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Regional climate models for NE Germany project lower precipitation in summer and increases in winter. With the projected rise in temperature and the higher frequency of extreme climate events, these changes will impact tree-growth. On sandy soils increasing drought may weaken the competitive superiority of beech (*Fagus sylvatica* L.) over other, more drought tolerant species, e.g. oak. On loamy soils stagnating wetness in spring may also impact growth performance of tree species as anoxic conditions become more frequent. In a dendrochronological study, we sampled five mixed stands of beech and oak (*Quercus robur* L.); three on sandy soils along a west-east gradient of declining precipitation and two on gleyic soils. On sandy sites water availability during summer mainly influences growth of both species and summer drought leads to growth reductions. Drier conditions in the east results in overall smaller growth rates and an increased sensitivity to climate. This increasing climatic forcing along the gradient is more pronounced in beech chronologies, indicating a higher drought tolerance of oak. Thus, the expected overall future drier conditions during the growing seasons are likely to affect the growth of beech more than oak. An observed higher sensitivity and a higher frequency of pointer years during the last decades in beech indicates that increased climatic variability have already influenced growth of beech especially on the central and western sites. On gleyic soils we found significant influence of spring-inundation only in beech, with the superficial drying of the gleys during summer significantly influencing soil moisture conditions and beech growth. The deeper rooting depth of oak makes it more tolerant against soil drying, since no significant influence of summer drought on oak growth existed. Nevertheless, despite this climatic limitation, absolute growth rates of beech are still higher than those of oak on gleyic soils.

D3-O15: Using intraspecific variation to assess climate change impacts on lodgepole pine

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Species distribution modelling (SDM) typically operates at the species level. However, many species exhibit ecologically relevant intraspecific variation, and few studies have analysed the relevance of this for SDM. Here, we compare SDM at two levels of biological organisation, namely, a species as a whole or as a group of subspecies, for lodgepole pine *Pinus contorta*. We use MaxEnt to model the climate niche based on presence observations. In addition, we use growth transfer functions, an approach presented by O'Neill et al. (2008) that utilizes tree growth data from provenance trials.

For current climatic conditions, modelled lodgepole pine distributions are quantitatively and qualitatively similar across model approaches (MaxEnt vs. growth transfer functions) and level of biological organisation (species vs. subspecies). For future climatic conditions, however, projections of lodgepole pine distributions diverge. In particular, when the species is considered as a conglomerate of differentiated, locally adapted subspecies, the species is projected to better tolerate climatic change. In contrast, the choice of model approach (MaxEnt vs. growth transfer functions), which can be an important source of variation in model projections, has comparatively little effect in our case. We conclude that intraspecific variation presents an important challenge for SDM.

D3-O16: Partitioning mortality dynamics of beech in a near natural forest

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Tree mortality is one of the key processes in forest dynamics. A mechanistic and predictive model of mortality is an essential prerequisite to correctly model establishment, species distribution and tree biomass in forests over longer time periods. Such a model needs to include the different causes of mortality and their respective drivers.

I modelled tree mortality of different processes and embracing the whole life history of trees from sapling to gapmaker in a near-natural deciduous forest stand in central Germany.

Methodologically I focused on bringing together growth measurements of dead and live trees (repeated dbh-measurements and tree-rings), dealing with measurement errors (negative growth), imputation of missing growth measurements, and error propagation, all in a framework of Bayesian analysis. I will illustrate that these methodological features and especially the knowledge of the proximate mortality cause and hence a partitioning of mortality are essential for the development of mechanistic mortality models.

D3-O17: Scale dependence of vegetation-environment relationships in forests

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The importance of different drivers for species composition and phytodiversity may change with spatial scale. At very small scales clonal growth, chance, and competition between individuals may be the most important factors. With increasing scale soil conditions may become increasingly influential for total species composition, while small-scale effects of competition and chance may cancel each other out. However, heterogeneity of site conditions will also increase with larger plots which should blur vegetation-site relationships at very large spatial scales. In forests these scale-dependent relationships are further complicated by the height differences of the structural layers and by the heritage of past forest management. To investigate the effect of spatial scale on vegetation-site relationships and to test our hypotheses we studied temperate deciduous forests near Greifswald (Northeast Germany). Along the sampled gradient of soil moisture the dominant tree species changed from *Alnus glutinosa* on sites with very high groundwater level over *Fraxinus excelsior* and *Quercus robur* on soils with temporary water saturation to *Fagus sylvatica* on well drained upland soils.

We sampled vegetation at 6 spatial scales in a nested plot design ranging from 0.01 m² to 400 m². Soil data were sampled at the four largest spatial scales (1 m² to 400 m²) and various soil characteristics where analyzed for the topsoil. We analyzed the strength of the vegetation-site relationships using CCA.

As expected by our hypothesis we observed a general increase in the vegetation-site correlations with increasing spatial scale, but with differences between the herb and the tree layer. Our results help to identify suitable plot sizes for the analysis of vegetation-environment relationships in temperate forests.

Poster Presentations

D3-P1: Effects of forest establishment on plant diversity: a retrogressive analysis

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Biodiversity conservation, in the face of increasing human impacts and global environmental changes, requires accurate analysis of multi-temporal patterns and effective management actions at landscape scales. Historical ecological data are needed to calibrate predictions of future global change impacts on biodiversity; when historical ecological data are not available, one key lies in extrapolating them through the construction of ecological models that include the use of historical cartographic data. This work aims at developing an approach to estimate backward in time plant diversity shift in response to land use changes and analyzing the potential effect of afforestation, occurred in the last 60 years, on heterogeneity and plant species richness in a Mediterranean context. The field data from an extensive monitoring program (Mo.Bi.SIC) and a nearest neighbour selection were used to model the plant species diversity change and rebuild the past species pool matrix. Species-based rarefaction curves were derived for the two dates (1954 and 2010) to estimate temporal changes in alpha and beta diversity. The results showed that the methodology developed for this work it may serve as an approximation in the analysis of the effects of the establishment of forest on forest plant species richness. This method, although aware of its weakness compared to direct multi-temporal field studies in the analysis of ecological dynamics, could serve as support in the purely quantitative cartographic analysis. The estimation of species diversity change through our model represent a formalization of what could be expected analysing land use spatial pattern changes. From a nature conservation perspective, the process of abandonment of traditional management techniques in favour of agriculture intensification and reforestation is quickly producing an overall homogenization of the landscape.

D3-P2: Vegetation-environmental relationship across Kheirudkenar forest, Hyrcanian area

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Hyrcanian forest is a unique closed canopy of mesic deciduous trees in northern Iran contrasted to the arid and semi-arid steppe landscapes throughout most of the country. The objective of this research was to study the relationships between environmental factors and vegetation in order to find the most effective factors in the separation of the vegetation types of Hyrcanian forest in north of Iran. A classification of vegetation and ecological characteristics were carried out using data extracted from 234 relevés followed the Braun-Blanquet approach in Kheirudkenar forest, a relatively intact area of Hyrcanian. The data were analyzed using TWINSPAN and ordination methods (DCA). The forest vegetation was classified into five large groups. The first vegetation group was characterized by *Anemone caucasica*, *Paeonia wittmanniana* as indicator species. This group is located at the highest elevation (2100 m) in the study area. The second group is dominated by *Fagus orientalis*, *Mercurialis perennis*, *Ruscus hyrcanus*. The third vegetation group mainly consists of geophytes, chameophytes and endemic and subendemic species, distributed in the higher altitudes. This vegetation is mainly characterized by indicator species such as *Cardamine bulbifera*, *Carex pendula* and high level of clay in the soil. The fourth vegetation group distributed in submountain and lowland forest. *Oplismenus undulatifolius* and *Parrotia persica* are as dominant species. The last vegetation group is characterized by *Circaea lutetiana* and *Euphorbia amygdaloides*. Five vegetation groups can be differentiated on two first axes of indirect ordination. The results indicate that altitude, soil texture and other dependant environmental variables (e.g. pH) are the main environmental factors affecting the distribution of forest vegetation groups.

D3-P3: The role of disturbances for long-lived pioneer species in New Zealand's forests

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New Zealand's indigenous forests are characterized by the coexistence of long-lived coniferous pioneer species and fast-growing, shade-tolerant angiosperms. Despite knowledge about the species' life-history traits, the coexistence mechanisms and long-term dynamics of those forests are still to be resolved. Large-scale disturbances are hypothesized to be a key process for allowing the coexistence of angiosperms and conifers with contrasting life history strategies. Using the dynamic forest-landscape model LandClim we investigate the long-term dynamics of an altitudinal transect in a forest at Mount Hauhungatahi, in the central north island of New Zealand.

We aim to simulate a) the effect of large-scale catastrophic disturbances such as the Taupo eruption (1718 cal. BP) on species succession and b) the role of smaller-scale disturbances like windthrow on the current forest structure and composition.

The model produces successions which agree with the general picture given by pollen records. Over the course of succession the forest is first dominated by the long-lived conifer pioneer *Libocedrus bidwillii* until it is progressively replaced by the emergent angiosperm *Weinmannia racemosa*. The current state of the forest is characterized by the strong dominance of *Weinmannia racemosa* in the lower montane area with *Libocedrus bidwillii* occurring only at high elevations in the sub-alpine area where disturbances are more frequent and competition is reduced. An exploratory analysis of a range of disturbance scenarios highlights the functional significance of disturbance events for the structure and spatio-temporal dynamics of New Zealand's mixed angiosperm-conifer-forests, especially for long-lived pioneer species.

D4 Movement Ecology in changing landscapes

Oral Presentations

D4-O1: Body size constraints for pollen-collecting solitary bees

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Bees provide pollination services to crops and pollinate wild plants. There are also limits to their potential concerning activity range and behaviour. Honeybees and bumblebees are well-studied, but we know little about the potential of the many small solitary bees. We developed a framework for pollen collection behaviour in relation to body size. Pollen collection is the main motivation for solitary bees to move in the landscape and understanding body size constraints is necessary to understand their movement in the landscape. We reviewed the literature on the following main topics: flight performance (foraging ranges, velocities), visual abilities, pollen collection (transport capacity, flower handling time) and other behaviour (foraging time, choice of flower size). We show that small bees differ quite much from large bees and discuss the consequences. We propose that describing the size composition of bee communities in ecological studies would help understanding their response to spatial landscape features. Our review shows that basic understanding is present in the literature, but that the available data does not suffice for detailed understanding. Especially the lack of good data for large solitary bees can result in unreliable trait-size relationships that deviate between studies and possibly lead to wrong conclusions.

D4-O2: The role of macropters during range expansion of wing-dimorphic insects

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Rapid range shifts are one of the most conspicuous effects of global warming. Marked changes in distribution have been observed not only for highly mobile insect taxa, which are capable of flight, but also for wing-dimorphic species with predominantly short-winged individuals. In the special case of wing-dimorphic species, it is likely that the rarer long-winged (macropterous) morph plays an important role in the dispersal process, but less is known as to how and to what extent it is involved. Therefore, we conducted a field study to provide additional insights into the complex dispersal processes of wing-dimorphic insects at expanding range margins. From an ecological point of view, this specifies the role of individuals capable of flight of a predominantly flightless species and estimates the general adaptability of wing-dimorphic insects during periods in which the environment is changing. We documented conspicuous dispersal patterns at the recently expanding range margin for our model organism *Metrioptera roeselii* (Orthoptera: Tettigoniidae). We found intensified dispersal behaviour in quantity (more

dispersive macropters) in recently populated areas. Moreover, *M*. *roeselii* has shown distinctively higher dispersal ability (% macropters) in recently established populations at the expanding range margin compared to populations characterised by medium- or long-term establishment nearer to the range core. The present study provides additional evidence of special ecological and evolutionary processes at range margins, expressed in increased dispersal ability and behaviour. Our results illustrate that macropters are the driving force of the recent range expansion of wing-dimorphic insects, as they increasingly occur within expanding margin populations and as dispersers in uncolonised areas.

D4-O3: Mud snails move with fat tails

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While moving through the landscape animals should optimize their foraging efficiency. How they accomplish this task is yet generally unclear. If food is rare and animals have limited information of their surroundings, foragers have been hypothesized to move randomly with fat tailed step length distributions, often referred to as Lévy walks. In contrast to previous studies using tracks of wild animals to test it, we examined foraging movement of a simple organism in the lab.

We studied the foraging patterns of mud snails (*Hydrobia ulvae*) in different experimental landscapes in which 10% was covered with algae. Algae distributions in space were chosen to be either random, regular or fractal. As control we examined snail movement on bare mud and fully covered algae landscapes, respectively. We determined and analyzed the snails' step length and turning angle distributions using high frequency recordings of their positions.

Step length distributions of individual snail movement on bare, fully covered and fractal landscapes show fat tails, often being well fit by truncated power laws. On random and regular landscapes snail tracks resemble Lévy walks less well, but approximate Brownian walks. Additionally, movement is clustered on food patches as well as on bare mud, but snails seem to reorient after food encounter and move slower when feeding on a patch of algae.

Our results clearly show the prominence of Lévy motion under spatially homogeneous conditions, pointing out that Lévy walks are a baseline movement strategy for mud snails. The comparison with movement in different, heterogeneous landscapes indicates that these Lévy walks are modulated to Brownian walk-like patterns by frequent food encounter. Moreover, our results suggest that the Lévy walk strategy is most efficient in fractal landscapes, which resembles food distributions encountered in their natural habitat.

D4-O4: Random walks, intelligent movement and mental maps: comparing search strategies

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Animal movement strategies that optimize search efficiency have raised considerable interest. This and the availability of detailed movement and dispersal data motivated Nathan and colleagues recently to published their much appreciated call to base movement ecology on a more thorough mechanistic basis. So far, most movement models are based on correlated random walks (CRW). However, even if a random walk might describe real movement patterns acceptably well, there is no reason to assume that animals move randomly. Bayesian foraging strategies based on information and memory use seem to be much more appropriate concepts here.

We present a mechanistic movement model of an animal with a limited perceptual range and basic information storage capacities. This “spatially informed forager” constructs a mental map of its environment, i.e. a spatially explicit utility function, by using (evolutionarily acquired) assumptions about the spatial correlation of resources to supplement the environmental information it perceives. We analyse the resulting movement patterns and search efficiencies and compare them to CRWs, biased correlated random walks (BCRW) of omniscient individuals and spatially uninformed strategies. We show that, in spite of their limited perceptual range, spatially informed individuals may perform nearly as well as those following a BCRW. This construction of a mental map results in a highly correlated walk between patches and rather systematic search for resources within resource clusters. Our work highlights the strength of mechanistic modelling approaches and sets the stage for the development of more sophisticated models of Bayesian strategies in foraging and dispersal.

D4-O5: Estimating cheetah population size using high resolution movement data

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The Namibian rangeland is the core habitat for cheetah conservation but a density estimate of the cheetah population remains vague. Previous estimates were mostly based on questionnaires, personal communications with farmers and reported sighting. This is problematic since solid density estimates are a prerequisite for evaluating potential conservation measures such as human-carnivore conflict action plans. Capture-mark-recapture is widely used to estimate felid densities, however, this method is often constrained by high costs and time effort which often result in irregular trapping periods that limit the density estimate.

Here we present a new method using temporarily high resolution movement data of cheetahs to estimate cheetah population density on central Namibian rangelands which can also be applied for other habitats and species. We developed an individual-based model that simulates cheetah movements and virtual trapping events. Model rules to simulate the distance and direction of cheetah movements were derived from telemetric and trapping data of a field study since 2002. Using a virtual ecologist approach and applying the identical irregular trapping design from the field study, our model was able to reproduce movement patterns recorded from GPS-tracked cheetahs, and to estimate cheetah population density by systematically varying the number of simulated cheetahs until simulated and field capture data matched.

Poster Presentations

D4-P1: Evolution of White Stork migratory behaviour following optimal annual routines

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Understanding and making quantitative predictions of how organisms respond to changing environments are key challenges in present-day conservation ecology. Especially in migratory species, individual fitness and consequent population dynamics may be differently influenced by environmental conditions experienced throughout the summer and winter ranges or on route. In White Storks (*Ciconia ciconia*), different behavioural adaptations in response to habitat alterations and climate change have been observed including changes in foraging preferences, timing of migration or the choice whether migrating at all. Here, we use an individual-based approach to model optimal individual behavioural strategies throughout the annual cycle ('annual routines'). Thereby, behavioural decisions depend on the individuals' physiological state, energy expenditure, the time in the annual cycle, available forage, presence of competitors as well as other mortality risks (e.g. predation), and follow optimality rules based on long-term fitness considerations. We follow a simple-to-complex approach starting with identical individuals and gradually introducing variations in traits related to reproduction, movement and density dependence. By that, we are able to identify key (interacting) traits determining the storks' migratory behaviour and assess related fitness consequences. The framework also allows us to study the evolution of different behavioural strategies and its consequences on long-term population dynamics in response to scenarios of environmental change.

D4-P2: Space use of mammals: impact of land use, resource dynamics and habitat fragment

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Agricultural intensification negatively effects biodiversity and ecosystem functions due to changes in field management and habitat fragmentation. 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.

In a pilot study started in 2011 we study influences of land use patterns and resource availability on the spatial movement and behaviour of multiple species to develop predictive space use models. We apply automated GPS-based radio tracking to monitor movement, activity patterns and acceleration of European hares (*Lepus europaeus*), red foxes (*Vulpes vulpes*), raccoon dogs (*Nyctereutes procyonoides*) and raccoons (*Procyon lotor*). Besides the automate recording of animal behaviour we also sample environmental variables, in particular land use and crops, field management, landscape complexity and food availability. The study takes place in the Uckermark region in North-East Brandenburg, Germany, which is characterized by different levels of landscape complexity in a highly intensive agricultural area.

1. Intensity of animal movement and activity patterns can be related to species traits, allometric relations, landscape complexity and land use variability.
2. Disturbances through agricultural practice and resource availability influence movement decisions (e.g. migration, dispersal, foraging) to different extends.

D4-P3: The importance of landscape configuration for home range sizes of red deer

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Understanding the determinants of home range dynamics is relevant for both basic science and conservation. Recently, several studies have analysed changes in home range sizes in deer species at several temporal scales. In these studies, landscape conditions were represented via landscape composition, i.e. the relative proportion of different habitat types. Here, we extend these analyses by including measures of landscape configuration, i.e. the spatial arrangement of habitat types. We analyse the dynamics of home range sizes of 30 red deer (*Cervus elaphus*) over nine years in the Bavarian Forest National Park. Using mixed effect models, we quantify the importance of weather, landscape composition and configuration at three temporal scales (weekly, biweekly, monthly). We find that landscape configuration is a dominant factor for explaining home range variability. Home range sizes increases when the landscape configuration shows a low aggregation of landcover types. We conclude that the configuration of the landscape needs to be accounted for in the analysis of home range sizes. A promising next step will be the analysis of movement paths in order to suggest mechanisms that lead to differences in home ranges at different landscape configurations.

D4-P4: Influence of forest structure on roe deer habitat selection using airborne LiDAR

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Understanding habitat selection plays an important role for the management of roe deer (*Capreolus capreolus)*. Beside other environmental parameters habitat structure has a major influence on movement behaviour of the species as shown in other studies. Data from airborne laser scanners (Light detection and ranging, LiDAR) can be used to derive three-dimensional vegetation structure over large areas and therefore show high promise for analyzing wildlife habitat relationships. In this study we applied step selection functions (SSL) to model habitat selection dependent on LiDAR derived structural parameters. For the analysis of movement behaviour we used GPS telemetry data of roe deer from the Bavarian Forest National Park. Forest structural parameters calculated from discrete-return airborne LiDAR-data were mean canopy height, variance of canopy height, openness of the canopy and cover of shrub layer. Furthermore a LiDAR derived digital elevation model was integrated. A special focus of our analysis is put on temporal variations of habitat preferences at several scales and differences between the sexes.

E1 Ecological consequences of land use change

Oral Presentations

E1-O1: Abundance and population-energy use in forest-soil communities

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Communities usually consist of species that are abundant and those that are rare. This pattern can be explained by the energy use of differently sized individuals. Body mass influences metabolic rate and hence the energy demand of the whole population. It therefore determines the feasible number of individuals of different species in a community and thus their abundances. Which rules describe these relationships of body mass and abundance and which the relationship of body mass and the energy demand of a population (population energy use, PEU)? We investigated forest-soil communities in respect to abundance and population energy use, we focused on meso- and macrofaunal invertebrates across ten phylogenetic groups sampled at 52 forest soil sites. Several land-use types were chosen, which were replicated in each exploratory (Biodiversity Exploratories). Animals were extracted and identified to species level, wherever possible and abundance per sample counted. Body masses of soil animals were calculated and mean body mass determined. The collected samples resulted in 585 species in ten phylogenetic groups. The body masses ranged over nine orders of magnitude with the smallest represented by juvenile mites and the largest represented by earthworms. We calculated population energy use (PEU) and determined the slope of the abundance-mass relationship and of the PEU-mass relationship on double logarithmic scales for each of the phylogenetic groups combined with each of four forest types. The relationships are mostly driven by the identity of the phylogenetic group, whereas forest type only has a marginal effect on the relationships. Population-energy use increases with increasing body mass of the species which indicates that larger species are able to use energy more efficiently than smaller ones.

E1-O2: Soil, litter and herb layer changes after conversion to spruce monocultures

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The effects of tree species conversion on the herb layer, soil chemistry, humus type and earthworm communities has been thoroughly studied. However, the size of such change trajectories as a function of initial soil trophicity has not been looked at in a systematic way. The objective of this study is to achieve a better understanding of the change trajectories and how these relate with herb layer, topsoil characteristics, humus type and earthworm communities by multiple pair comparisons of seminatural and converted tree stands along a soil trophic gradient.

In the south of Belgium, we selected 40 even-aged stands of 2–5 ha of *Picea abies* (Norway spruce) between 30 and 50 years of age. These stands were located in a matrix of mixed deciduous forest with main species *Carpinus betulus*, *Quercus robur*, *Fagus sylvatica*, *Quercus petraea* and *Fraxinus excelsior*. In the spruce stands as well as in and the adjacent deciduous forest, vegetation was described (three, shrub and herb layer), litter type determined, soil chemistry measured and earthworm community characterised. Spruce and deciduous stands were compared and causal relations between factors were tested with path analysis.

In general, spruce stands acidified soils, caused higher litter masses, changed vegetation towards more acid tolerant species and decreased the earthworm population significantly. The herb layer diversity was not affected by conversion to spruce. It also seems that the earthworm community, and especially the burrowing earthworms (endogeic and anecic), are important to keep a mull humus type in this forest ecosystems. Preliminary results indicate that the change trajectories were larger in richer soils with higher buffer capacity. Thus, these results show that transforming semi-natural deciduous forest to spruce monocultures causes a site-dependent ecosystem shift from a mesotrophic to an oligotrophic state.

E1-O3: Seedling and sapling survival in West-African savannas is related to land-use

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In frequently disturbed habitats like savannas the survival of seedlings and saplings relies on re-sprouting capacities following disturbance by removal of above-ground biomass. This requires that individual plants had sufficiently allocated and stored reserves. Furthermore, the extent to which species may resist to frequent disturbances is related to site conditions as nutrient availability, water supply, and frequency of fires and herbivory. These factors may limit the development of plant individuals to later life stages. Hence, young individuals may persist in a quasi permanent stage for several years, where no increase in stem length can be observed but an increase in stem diameter. We hypothesize the larger the stem diameter the higher the survival probability. In this study we address the following questions (1) Does the survival probability following disturbance increase with increasing diameter? (2) Is there a minimum diameter for survival? and (3) Are survival rates affected by site conditions?

Three land cover types with different site conditions and land use practices were studied: non-arable sites, fallows and semi-natural tree and shrub savannas. In two annual censuses from 2008 to 2010 we studied individuals of 19 woody species less than 1 m in height. We use multistate capture-recapture statistical models to estimate survival and transition rates among diameter stage classes.

We detected seasonality to have an important impact on survival of seedlings and saplings in our study area. Furthermore, our results indicate an influence of land use on transition probabilities among diameter stage classes and survival rates. Concerning our assumptions that survival probability depends on diameter class, we expect species specific results. With our ongoing analyses we aim at revealing ubiquists and specialists due to differences in their survival and growth in relation to land use.

E1-O4: 10 years of land use impacts on species diversity in savannah rangelands

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Land use has lead to serious changes in savannah landscape structure worldwide. In particular, shrub encroachment due to heavy grazing practices is considered to be one of the most threatening forms of rangeland degradation and to alter plant species composition and abundance. However, possible impacts of shrub encroachment on animal diversity remain poorly understood. In this study, we analyzed land use impacts on vegetation cover of dominant savannah plants and species diversity of top predators (i.e. small and medium sized mammalian carnivores) and one of their major food source (i.e. rodents). In particular, we recorded changes in vegetation cover and mammals along a land use gradient between 2001 and 2011. Changes in rodent population size and species richness were determined using capture-mark-recapture and carnivore abundance and species richness using the track intrusion index TII. Results show that the extend 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. Land use induced changes in vegetation cover affected rodents and carnivores significantly. Particularly in heavily degraded savannah rangelands, the regeneration potential of top predators was very low despite the high abundance of rodents in years of above average rainfall. Nevertheless, moderate and well managed land use can maintain healthy populations of top predators.

E1-O5: Escaped ornamental species in village floras promote taxonomic homogenisation

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Agriculture and urbanisation shape biodiversity through extirpation of species and facilitation of species introductions. These can result in changes in the functional composition and homogenisation of species assemblages. Especially the spread of exotic species has been discussed as a driver of homogenisation. However, no consensus has been reached so far; instead, both homogenisation and differentiation by exotics have been shown. This inconsistency can partly be attributed to the lack of temporal data: most homogenisation studies rely on purely spatial analyses, while homogenisation develops over time. We studied vascular plant species occurrences in 59 villages in the West of Germany in the 1980ies and twenty years later. Within this period, the villages experienced changes in agriculture and trends towards urbanisation. We asked whether the villages' floras became more similar to each other within the study period, and whether this could be attributed to gains or losses of species within selected plant groups. We based plant groups on leaf traits and on species exotic status and mode of introduction. This enabled us to relate changes in the flora to changes in land use. Simpson's index of dissimilarity identified beta-diversity among villages and between time spans as measures of turnover and homogenisation. Tests of association identified species gains and losses within plant groups. Within the study period, exotic species had significant homogenising effects, driven by the spread of ornamental species that escaped cultivation. Formerly typical village species such as agricultural weeds declined as a consequence of agricultural changes, as did species adapted to moist and wet habitats. Together, species gain and loss resulted in a mean turnover of 53% per village. Our study provides evidence that exotic plant species homogenise species assemblages over time, even if this effect is not detectable in purely spatial studies.

E1-O6: Responses of herbivory and pollinators to grassland management and plant diversity

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Agricultural intensification is one of the main drivers of global environmental change. Research trying to experimentally disentangle plant diversity from management effects, like fertilization and mowing, on biodiversity of higher trophic taxa and related functions is crucial for conservation recommendations.

To understand influences of land use and plant diversity on herbivory, grasshoppers and pollinators, we experimentally set up different management regimes along an experimental plant diversity gradient within "The Jena-Experiment" in Eastern Germany.

The percentage of herbivory, the number of grasshopper individuals and the diversity and frequency of pollinators were estimated in four subplots of the plant diversity plots. Each subplot was differently managed, spanning a grassland management gradient from very low, low, medium to high intensive. Fertilization and mowing, but not plant diversity significantly affected plant-herbivore interactions. While grasshoppers were most abundant at fertilized plots, leaf damage caused by herbivores was highest in high fertilized plots with four mowing events a year. In contrast, pollinators benefited most from the medium extensive management intensity with two times of mowing and no fertilizer addition.

Our results indicate that moderate mowing intensity of no more than two events and without fertilizer are grassland management practices to minimize trade-offs between ecosystem services and dis-services; while the beneficial pollinators were promoted by medium extensive management intensity, herbivores did not deplete high amounts of plant biomass.

E1-O7: Abandonment and re-mowing in species-rich *Festuca paniculata*-grassland

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Subalpine *F. paniculata*-grasslands result from a light management and are therefore limited, as most of them have been abandoned since the begin of the 20th century due to socioeconomic changes in mountain agriculture. Utilizing homogeneous site conditions and different times of abandonment within a small area, succession processes have been studied using a chronosequence approach. Based on detailed historical maps and local stakeholder information there have been identified six time steps of abandonment starting from 1850. Comparison of vascular species composition, yield, soil parameters and reforestation lead to a determination of four succession stages with *F. paniculata* acting as a key factor. The first phase (0-10 yrs) is characterised by a significant loss of species richness and quality yield due to the increasing dominance of *F. paniculata.* During the second stage (10-40yrs) this dominance is still reforced, however: despite the lower Evenness-Index species richness showed no significant decrease during this period. With the appearance of the first shadowing trees there was observed a dramatic reduction of *F. paniculata* within a short time (3rd stage, 40-60 yrs). During this transition period quality yield shows a short-termed increase before breaking down simultaneously with species richness in the last succession stage, were the climax community (Larici-Piceetum) is reached (>60 yrs). Re-mowing experiments point out a reversibility of the first three succession stages just within a few years, whereas a reversion from the last stage is only possibly by high labour and time effort. The obtained results point out the sensitivity of this plant community against slight environmental changes and suggest the possibility for recently abandoned areas to recover the high initial value just with relatively small effort.

E1-O8: Effects of soil texture, grazing and climate on Orthoptera of steppe grassland

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In Western society's intensively used landscapes biodiversity suffers either from land use intensification or abandonment. Since it is difficult to re-establish natural dynamics, traditional land-use forms like grazing are important tools of nature protection. The steppe grasslands of the Lower Oder Valley (NE Germany) are hotspots of biodiversity; however, they are threatened by abandonment. We examined the impact of grazing on species richness and abundance of Orthoptera inhabiting the most xerothermophilous steppe grasslands: the feather grass steppes. For this aim we sampled a total of 3,547 individuals belonging to 22 species on 46 patches during two sampling periods (June and August) and examined several environmental variables concerning vegetation structure and soil characteristics. In general, diversity and densities of Orthoptera were high in the steppe grasslands. Compared to the fallow grasslands, managed patches had higher densities, more threatened species and a higher share of geo-chortobiont species. However, the influence of grazing was not as big as predicted and varied between sites with different soil texture. Steppe grasslands on unproductive sandy soils were less sensitive to abandonment and provided favourable microclimate for Orhtoptera, even if fallow. Our results also illustrated that Orthoptera niches shifted during the season. While in June abundance was correlated with a favourable microclimate, in August food supply appeared to be the most important factor. Based on our results steppe grasslands should be managed, particularly by grazing, to promote Orthoptera. To allow seasonal shifts and to buffer against climate change structural heterogeneity of the patches should be increased.

E1-O9: Increasing land-use intensity decreases floral colour diversity in grasslands

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To preserve biodiversity and ecosystem functions in a globally changing world it is crucial to understand the effect of land use on ecosystem processes such as pollination. Floral colouration is known to be central in plant-pollinator interactions. To date, it is still unknown whether land use affects the colouration of flowering plant communities. To assess the effect of land use on the diversity and composition of flower colours in temperate grasslands, we collected data on the number of flowering plant species, blossom cover and flower reflectance spectra in two German regions. We analysed reflectance data of flower and leaf colours as they are perceived by bees and studied floral colour diversity on 35 plots based upon the mean flower colour loci of each plant species in bee colour space. Flower colour diversity decreased with increasing land-use intensity, entailing an increasing proportion of white flowering plant species and their blossom cover compared to yellow and blue flowering plant species. By

changing colour characteristics of grasslands, we suggest that increasing land-use intensity might affect the flower visitor fauna in terms of diversity, frequency and visitor behaviour. These changes may in turn influence plant reproduction in these grassland plant communities. Our results indicate that land use is likely to affect communication processes between plants and flower visitors by altering flower colour traits.

E1-O10: Influence of land use on a tritrophic system in three landscapes

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It has been shown in several instances that plant species diversity decreases with increasing land use intensity. Little is known, however, on how land use influences the functionality of higher trophic level interactions. We investigated the influence of fertilization, grazing and mowing on the flowerhead community of *Plantago lanceolata* and the surrounding vegetation in three different landscapes (Schorfheide-Chorin, Hainich, Alb) over three years.

Land use exerted a negative influence on plant species diversity. Although the host plant, *P. lanceolata,* was not at all or positively affected by land use the probability of occurrence of higher trophic levels in the flowerheads significantly decreased with increasing fertilization and mowing (vs. grazing). We discuss different hypotheses to explain these patterns.

E1-O11: Disentangling land use and climate change impacts on bird community patterns

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Human land use and climate change are regarded to be the main drivers of present-day and future species extinctions. They will potentially lead to a profound reorganisation of the composition and structure of natural communities throughout the world. However, studies that explicitly integrate both impacts of land use and climate changes are not very common. Here, we quantify community change of Dutch breeding bird communities over the past 25 years by time lag analysis (TLA) and we evaluate if it is caused by climate change or habitat change by calculating the chronological sequence of the community temperature index (CTI, indicates the significance of northerly vs. southerly species in the community) and the community specialisation index (CSI, indicates the significance of generalist vs. specialist species) over time. We show that the breeding bird fauna underwent distinct directional change and that this is caused by both climate change and land use change. The larger change in CTI than that in CSI suggests that climate change has become more important than land use change at the national scale. The assemblages of particular breeding habitats, however, do not change at the same speed and are not equally affected by climate versus land use changes: while CTI is rather constant in the rapidly changing farmland habitats, CSI is declining in this habitat. In contrast CTI is increasing in more slowly changing forest and heath while CSI is stable in these habitats. Coastal assemblages are experiencing both a decline in CSI and an increase in CTI, while in wetland birds neither CTI nor CSI show a significant trend although they experience the fastest community change among all breeding habitat assemblages. We conclude that the combined application of TLA, CTI and CSI is a valuable approach for disentangling the effects of land use change and climate change on natural communities.

E1-O12: European land-use change scenarios and ecosystem service provision

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Scenario exercises are a tool for structured investigations of possible future trends, based on sets of assumptions about drivers of change and their effects on complex socio-ecological systems. They are increasingly applied in environmental studies, providing descriptions of plausible outcomes of certain policies, economic and social trends and their interactions with ecological variables. The “storylines” of alternative scenarios are usually produced by interdisciplinary expert panels and can include stakeholder consultations. Scenario development can as such be an end in itself and inform policy-making directly, but they often serve as a framework to formulate research questions and create research designs for subsequent modelling, observational studies or experiments. Because of their nature they allow to include levels of complexity that are not accessible to more technically constrained modelling techniques.

In the EU-funded research project SOILSERVICE, recent scenario studies focusing on possible future trends in European land use were reviewed together with the results of model-based quantifications of the scenarios. The scenario-based modelling results concerning land-use change over time-scales of 10 to 70 years are presented in the context of ecosystem functions and ecosystem services, with a particular focus on carbon cycling in agricultural areas. Implications of the scenarios for soil biodiversity and feedbacks to ecosystem service provision in cultural landscapes are investigated, and an ecological view of policy options to influence land management that are currently being discussed in Europe is given.

Poster Presentations

E1-P1: The mangrove forest of Mtwapa Creek Kenya: How certain is the future?

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Despite the alarming rates of decline in coverage and general deterioration of mangroves worldwide, over the past few decades there has been renewed efforts for conservation resulting from increasing awareness of the true value of mangroves. These together with other forms of disturbances which may be natural or anthropogenic, all result in frequent changes making the system quite dynamic even at a local scale. One way to characterize mangrove ecosystem, and to monitor changes is through the assessment of forest structure. In this study we assess the floral composition and regeneration in mangrove forest of Mtwapa Creek, Kenya along belt transects at 3 forest patches (Gung'ombe, Kitumbo, and Kidongo). We apply the use of both De Liocourt's and Weibull models to understand the underlying distribution of the population of trees and as measure sustainability.

Spatial distribution pattern of adults and juveniles varied among forest patches and they showed a close to uniform pattern (Morisita's dispersion Index, $I_\delta << 1$) for adult trees, but a tendency to random distribution ($I_\delta = 1$) for juveniles. The study site contained 5 out of the 9 mangroves occurring in Kenya with *Rhizophora mucronata* being the principal species in all the forest patches as reflected by the extremely high importance value relative to the other species. The forest is characterised by high abundance of lower utilisation class poles ('fito' and 'pau'). Diameter measurements of the principal species (*R. mucronata*) in the creek follow an inverse j shaped probability distribution indicative of a population of rapidly growing living organisms where heavy suppression is present, yet mortality is not excessive. The distribution deviates from the balanced diameter required to ensure sustainability in an uneven aged forest according to De Liocourt's model and Weibull's β being > 1 giving a picture of a slowly dying forest.

E1-P2: Biodiversity and ecosystem processes on Mt. Kilimanjaro under global change

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Biodiversity and supportive ecosystem processes maintained by tropical mountain ecosystems are threatened by the combined impacts of global warming and the conversion of natural to human-modified landscapes. The KiLi project aims at assessing biodiversity and ecosystem processes along altitudinal and disturbance gradients on Mt. Kilimanjaro (Tanzania, Africa), capitalizing on its world-wide unique range of climatic and vegetation zones. On a total of sixty study sites in both natural and human-disturbed ecosystems biodiversity (e.g. plants, soil arthropods, ants, bees, frogs, lizards, bats, birds), related ecosystem processes (decomposition, seed dispersal, pollination, herbivory, predation), and biogeochemical processes and properties of ecosystems (climate, soil properties and nutrient status, regulation of water and carbon fluxes, trace gas emissions, primary productivity, functional diversity) are analyzed. Further, in experimental gardens at different altitudes, transplant experiments will be performed to study species adaptability under modified climate conditions. By reanalyzing study sites with historical floral and faunal records we explore shifts in species distributions. Overall, the data will allow us (1) to infer the influence of climate and anthropogenic disturbance on both biogeochemical processes and biodiversity, (2) to quantify biodiversity-ecosystem functioning relationships along elevational gradients, (3) to estimate resilience and adaptive potential of natural and modified ecosystems to global change, (4) to examine negative feedbacks of disturbance on local climate and ecosystem processes and (5) to quantify temporal shifts in species distributions due to climate and land use change. The aim of this poster is to give an overview over the integrative activities and study design of the KiLi project.

E1-P3: The effect of land use change on vegetation dynamic processes

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Due to their high level of species richness and the increasing destruction by humans, southern-Chilean temperate forests have gained one of the highest conservation priorities worldwide. In the study-area, which is located south-east of the city of Valdivia, land use converted large natural forests into plantations, pastures, and agricultural land. The remaining forests are severely fragmented and suffer highly from human interventions. Apart from the plantations that dominate the recent landscape rural small-scale farmsteads still remain. Their land comprises a mosaic of pastures, shrublands and forests that are either used for livestock grazing and firewood cutting, or have been abandoned.

To date, few ecological research has been conducted in these kinds of cultural landscapes in Chile. However, they might maintain important components of biodiversity and ecosystem functions that provide important ecosystem goods and services.

The aim of this study is to identify the vegetation dynamic processes (degradation and succession) that underlay these vegetation patterns. Emerging variations in site conditions, biodiversity, species composition (plants and birds) and vegetation physiognomic structure are being identified with respect to land use impact. We expect to identify indicators within the vegetation for the mentioned processes. These indicators might also be related to changes in the provision of ecosystem goods and important services.

E1-P4: Reproduction and genetic diversity of *Trollius europaeus* in modern landscapes

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Many plant species are currently experiencing negative consequences of habitat fragmentation due to reductions in population size and disruptions in pollination services. Plants in specialized pollination systems like the *Trollius europaeus* and *Chiastocheta* interaction might be esp. vulnerable to such changes. We studied 19 populations ranging from 140 to 820 000 flowers located within a matrix of intensive agricultural land use and urbanization in Switzerland. The effects of population size, density and pollinator abundance on reproductive output and genetic diversity were investigated during a three year study combining field surveys, greenhouse experiments and an AFLP survey.

Our findings highlight that plant population size is not always the main determinant of reproductive success for populations, but that other factors such as plant density and the specific ecology of a pollinator and its interplay with other population parameters can be more important in determining the fate of a population. Furthermore, the effects of plant population size and floral density on pollinator visitation in *T. europaeus* vary across scales, with implications for plant fitness. Regarding genetic diversity, remnant populations of *T. europaeus* appear to retain their genetic diversity and seem capable of persisting under the present conditions.

Based on these results the current conservation of scattered populations within an agricultural matrix is effective. When assessing populations for conservation management, it is therefore important not to focus solely on pure plant population size in determining population viability. Even small and isolated *T. europaeus* populations may be viable and resistant to pollination-associated vulnerabilities depending on plant density at local (subpopulation) scales. Thus the persistence of *T. europaeus* bodes well for other plants in such communities and landscapes.

E1-P5: Disturbance as a key factor for the shrub-feeding butterfly *Satyrium spini*

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Calcareous grasslands are the most species-rich habitats for butterflies throughout Europe. Whereas we have a lot of information concerning the habitat requirements of threatened grass- and herb-feeding butterflies in calcareous grasslands often restricted to early successional stages, our knowledge concerning shrub-feeding species is scarce. Here we studied the oviposition preferences of a shrub-feeding butterfly, the Blue-spot Hairstreak

(*Satyrium spini*), in calcareous grasslands. The females preferred small, sunny *Rhamnus cathartica* shrubs with a warm microclimate for oviposition. Although shrubs are usually associated with late successional stages in grasslands *Satyrium spini* depended on early successional stages with young plants or suckers. For long-time survival of the species, we recommend rotational scrub cutting within the calcareous grasslands.

E1-P6: Indirect effects of phosphorus on fungivorous collembolans

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Phosphorus is an essential nutrient for all forms of terrestrial life; in agriculture, phosphorus fertilization leads to enhanced crop production. However, additionally to the costs of fertilization there are negative secondary effects like eutrophication of adjacent waterbodies through runoff and cadmium contamination of the soil. Not only due to this, effects of phosphorus on soil flora and fauna have to be expected. Soil fungi are an important part of the soil flora. As mycorrhiza they are symbionts conductive for plant growth, decomposers make nutrients plant-available through remineralisation. Also, most fungi serve as food for soil fauna. According to the Growth Rate Hypothesis there should be a positive effect of high phosphorus concentrations on fast growing organisms due to high phosphorus requirement for rRNA. In spite of this, a negative effect of high phosphorus concentrations had already been found for mycorrhiza fungi, this effect might be indirect because plants in mineral-rich soils do not require a symbiosis partner, since their own nutrient acquisition may be sufficient.

I researched the effects of high phosphorus concentrations on saprotrophic fungi. Also, feeding and reproduction experiments with collembolans were conducted to determine direct and indirect effects of different phosphorus concentration in the soil. A negative effect of high phosphorus levels on soil fungi was observed. For the collembolans, no direct effect of the phosphorus concentration was found, but an indirect negative effect for the fungivorous collembolan *Folsomia candida* was detected. In order to assess fertilization effects it is important not to focus only on plants but on the whole soil food web. There might be a negative indirect effect of excessive fertilization through e.g. disturbance of the soil food web or change of soil fungal-bacterial ratio.

E1-P7: Consequences of land-use change for root niche overlap and water balance

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Land-use intensification has led to reduced plant diversity in agricultural grasslands, which used to be among the most species-rich ecosystems in Central Europe. According to the species complementarity hypothesis, such a reduction in community diversity will lead to lower productivity, either due to increased competition or niche overlap (Tilman et al. 1997). A number of studies on the diversity-productivity debate have shown that lower plant diversity decreases aboveground biomass yield, yet the effect on belowground productivity is still largely unknown. We investigated the effect of intensified grassland use and reduced species diversity on fine root production and turnover, as well as on belowground niche axes, i.e., water cycling. At an old-field grassland site in the Solling Mountains, Germany, we established a three-factorial biodiversity experiment with the factors sward diversity, cutting frequency and fertilization regime. In total, 72 plots were established at the site (three diversity treatments x two cutting frequencies x two N levels x six replicates). We examined the response of root depth distribution (0-60 cm), fine root production and turnover (mini-rhizotron technique) to plant diversity and grassland management. Evapotranspiration and drainage were measured with small weighable lysimeters comprising undisturbed soil and vegetation. In a previous study conducted during the first two years of the experiment, root biomass was not significantly affected by grassland diversity or management, but there was a dominant positive effect of N-fertilization on aboveground biomass (Rose & Leuschner, in review). This presentation will describe (1) the consequence of loss of species groups from grasslands for the spatial variability of root production and turnover up to 60 cm soil depth and (2) the relationship between root overlap (competition) and root longevity with different management regimes and biodiversity levels.

E1-P8: Tucuruí dam reservoir in Brazil: fragmented forest on artificial islands

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The Tucuruí dam reservoir, created for ahydroelectric power plant in the Brazilian Amazon, contains hundreds of artificial islands where lowland tropical rainforest prevailed before. The present study aimed to test the core-area model in a fragmented landscape caused by the construction of the hydroelectric power plant Tucuruí. We studied variations in forest structure between the margin and interior of 17 islands of 8-100 hectares, 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. No significant differences were found in liana density, tree mortality or tree damage for margin and interior plots. The peculiar topographic conditions associated with the matrix habitat and shapes of the island seem to extend edge effects to the islands’ centres independently of the island size, giving the interior similar physical microclimatic conditions as 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.

E1-P9: Regional impacts of increasing energy maize cultivation on farmland birds

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The impact of the increasing cultivation of energy maize on the habitat function of agricultural landscapes for farmland birds was investigated at the example of five bird species using scenarios for a study area in the Northeast of Brandenburg. Skylark (*Alauda arvensis*), corn bunting (*Miliaria calandra*), lapwing (*Vanellus vanellus*), whinchat (*Saxicola rubetra*) and red-backed shrike (*Lanius collurio*) were selected as indicator species. These five species are typical farmland birds and show a great variability of their habitat requirements. Based on known preferences of the species in respect to the crop field architecture (plant densities and heights) and the crop cultivation period, we estimated the potential habitat suitability of the cultivated crops in the study area. Additional data on the biophysical landscape characteristics (e.g. soil types and variability, habitat types) allowed to determine potential breeding habitat areas as well as feeding habitat areas. Using five scenarios (state in 2003 (no energy maize cultivation), 15% energy maize cultivation, 30% energy maize cultivation, random and clustered distribution of the maize fields) the current state (2003) of the potential habitat areas was compared to the specific scenarios. The results show different responses of the specific bird species to increasing maize cultivation. Positive and negative modifications to both the potential breeding and feeding habitats were seen. It can also be pointed out that spatial clustering of crops can have a negative effect on the potential habitat situation especially on bird species which need specific physical habitat structures within or adjacent to the crop fields (like hedgerows, special soil types etc.). Spatial clustering of maize fields may decrease the habitat suitability of the landscape for bird species like lapwing, whinchat and red-backed shrike.

E1-P10: Mitigation strategies for farmland birds in bioenergy-dominated landscapes

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Farmland birds that use crop fields for nesting and foraging are sensitive to changes in landscape composition. The current conversion in the landscape towards increased biofuel crop production will expand in the near future according to European policies. We developed a spatially explicit landscape simulation model with combined effects of habitat suitability (landscape composition) and habitat diversity (landscape configuration) for single bird species, which enables us to simulate different scenarios and mitigation strategies. We show that the Skylark, Yellow Wagtail and Corn Bunting respond negatively to an increase in bio-energy crops, but that the magnitude differs between birds. From the tested mitigation strategies, the maintenance of (long term) set-aside fields and promotion of small crop fields (1-5 ha) have the most positive effect. In some cases it does not only mitigate the effect of bio-energy crops but also improves the general suitability of the landscape for farmland birds.

E1-P11: Influence of temperature and management on plant diversity and pollination

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Climate and management are two key drivers for patterns in biodiversity. These patterns change with global warming and management intensification. However little is known about the relative importance, interactions and non-linear-effects of climate and management on species richness of plants. We studied patterns in species richness and the distribution of pollination types in 34 alpine grasslands along an altitudinal gradient in the Bavarian Alps (Germany). The grasslands were managed by grazing, mowing or were not managed. Mean temperature during the growing season was measured on each site. Plant species richness showed a maximum at intermediate temperatures. Grazed grasslands supported higher species richness than mown grasslands or not managed grasslands. In contrast to our prediction maximum species richness of insect pollinated plants was observed at lower temperatures (higher altitudes) than the species richness maximum of wind-pollinated plants. The proportion of wind-pollinated plant species decreased with decreasing temperature, but we detected the converse pattern in the vegetation cover of wind-pollinated plants. Our results suggest that extensive grazing promotes a high plant diversity over the full subalpine gradient in the study region. Rising temperatures with climate change and an upward shift of the diversity peak of plants might result in a reduced all-over diversity due to reduced grassland area at higher altitudes.

E2 Assessing ecosystem functioning: How do we choose appropriate concepts and baselines?

Oral Presentations

E2-O1: Soil and vegetation patterns of the Okavango catchment, a basis to assess ESF and S

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The woodland savannas of southern Africa have been identified as one of the top ten global tipping point regions regarding change of biodiversity and cascading effects impacting on climate, biogeochemical cycles and biodiversity of other regions. The interdisciplinary research project "The Future Okavango" seeks to develop sustainable land use strategies for this ecoregion. Within this framework we investigated Miombo Woodlands of the upper catchment of the Okavango River in Southeast Angola. Due to four decades of civil war this region is considered "terra incognita" in terms of ecosystem research.

During a first field campaign we studied the landscape mosaic on a core site sized 5 x 20 km^2 representing a gradient from the river to the hinterland. Before sampling, major vegetation types were delimited by carrying out an image segmentation and cluster analysis of a Landsat scene to ensure random stratified sampling. Phyto-sociological relevés with plot sizes of 10 x 10 m and additional parameters describing topography and soil conditions were taken and mapped. The analysis of drivers determining natural vegetation patterns will be a first step to model the vegetation of the entire upper catchment. The results will facilitate the assessment of vegetation based ecosystem functions and services as an indispensible baseline information for sustainable land management options. This is increasingly relevant due to remigration to this region after the end of the civil war.

E2-O2: How diversity causes complementarity in ecosystem functioning: a review

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While it is now generally accepted that biodiversity affects many different ecosystem properties the mechanisms underlying these effects are still largely unclear. This is in particular true for the biology underlying complementarity effects. Here we review biological mechanisms by which communities of higher diversity can function in a complementary way and identify ecosystem properties for which an investigation of such underlying mechanisms is needed. We surveyed published accounts based on a search in web of science, reference lists of existing reviews on diversity effects, and forward citations of key articles. Over 1500 articles on the functional importance of diversity were screened. Compiled examples for biological mechanisms include the classic idea of resource use complementarity where diverse communities use nutrients more completely and/or more efficient as documented for plants' use of nitrogen and light (space) and feeding behaviour of decomposer macrofauna. There are also examples for temporal complementarity due to fluctuating abundances of species over time. Other mechanisms involve changes in the size or physiology of individuals in reaction to competition (phenotypic plasticity resulting in complementarity), lower host densities reducing disease spread, or behavioural interactions creating synergistic effects. In conclusion, a wide range of different mechanisms can be identified but only a small proportion of studies in biodiversity-ecosystem functioning research have so far explicitly addressed the biological mechanisms underlying the observed effects. We argue that there is an urgent need to address mechanisms in future biodiversity experiments.

E2-O3: Eight years of the Jena Experiment - a selective review

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In the past two decades, a number of studies have investigated the relationship between biodiversity and ecosystem functioning most of which focussed on a limited set of ecosystem variables. The Jena Experiment was set up in 2002 to investigate in detail the effects of plant species richness and plant functional group richness on closed element cycling and trophic interactions. Here we review the results of the eight years of research in the experiment.

About 40% of individual analyses of the effect of plant species richness on ca. 500 ecosystem variables measured revealed significant diversity effects. We review which ecosystem compartment and which components of element cycling and biotic interactions are more strongly affected by biodiversity and which ones are less affected. We also show where the experiment has led to progress discussing the mechanisms underlying the observed patterns and we point out the open questions that have arisen from the results. We discuss how the experiment developed over the past eight years and how both the observed patterns and the conclusions that can be drawn have been influenced by temporal trends in the results.

A main conclusion that emerges from our work is that the future of biodiversity research lies in understanding why the magnitude of biodiversity effects differs between processes. To gain a deeper understanding of the functional role of biodiversity, future studies need to concentrate on the identification of the mechanisms underlying the observed patterns, in particular on how ecosystem variables are driven by species interactions and how these interactions are affected by diversity.

E2-O4: Coastal protection as an ecosystem function: concepts of valuation

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Natural as well as artificial structures offer diverse “services” supporting the human efforts of coastal protection. The diverse structures of the subtidal, intertidal and supratidal areas, the complex hydrological and ecological processes occurring, and their dynamic will be used to give an – rather complex – example on how ecosystem functioning might be assessable.

The approach presented in this contribution is the basis of a concept to evaluate the vulnerability of coastal zones for climate change and sea level rise for the Wadden Sea Area. The mudflat landscape is highly variable in time and space, and critical tipping points of sea level rise are predicted. Discussing baselines as starting points for comparing different scenarios is the challenge of this concept.

E2-O5: Normative dimensions of conceptualising and assessing ecosystem functioning

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Like several other popular concepts in ecology and conservation biology (such as biodiversity, ecosystem services, or resilience) ecosystem functioning is not just a merely descriptive concept, but contains several normative aspects. This is especially pertinent to the common understanding of ecosystem functioning as the overall performance of whole ecosystems. Functioning here mostly refers in fact to „proper functioning“, i.e. the performance of an ecosystem in accordance with a reference state. As neither the question of what an ecosystem is nor what its (desired) reference state is and/or should be can be found in nature as such several choices have to be made in order to assess ecosystem functioning. These are in part individual and methodological ones, in part however, especially if related to conservation and management of ecosystems, also societal ones with moral implications.

The presentation will elaborate these arguments in more detail and provide examples of different options for conceptualising ecosystem functioning. It will then present a kind of checklist of the choices required for applying the ecosystem functioning concept in practice.

E3 Changing Landscapes - processes in time and space

Oral Presentations

E3-O1: Gathering GIS-processable landscape history data based on historical maps

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Landscape changes and their influence on biodiversity patterns are a challenging object of ecological research. The effects of land-use change, including alterations to the structure of landscapes and their elements are key drivers of widely observed changes in species distributions.

When addressing landscape changes over time it is crucial to obtain the necessary spatial data on a reasonable scale. Historical maps may provide a possible source of such information. Unfortunately, they typically exist only on paper which makes computational and statistical analyses impossible. Here, we present a project that brings historical maps together on a regional scale (covering the Mecklenburg part of the German federal state of Mecklenburg-Western-Pomerania) and makes them available in digital form for spatial statistics and further analyses. This is achieved by digitalisation of map signatures of scanned and geo-referenced historical maps following a unified data model that corresponds to the data model used by the land surveying offices today. The combined digitized map dataset covers a time of about 230 years in three major time steps (1786, 1888, today).

We demonstrate, how the obtained data can be applied to ecological research in different ways: For instance, such spatially explicit historical data allows for the identification of regions of continuity and discontinuity and to analyze the change of landscape structure (i.e. edge density and -length) over time. This in turn provides the basis for subsequent analyses of diversity patterns in relation to the age of landscape structure.

E3-O2: Analyzing landscape changes since 1850: a case study

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The aim of our study is to identify the driving forces for land-use changes and their consequences for 17 mountain regions in Tyrol (Austria) and South Tyrol (Italy). We choose nine study areas in Tyrol (Lechtal and Stubaital) and eight study areas in South Tyrol (Pustertal and Vinschgau) and subdivided it into eco-regions. This methodical approach allows comparisons between these diverse geographical regions over successive periods from 1850 to the present. Landscape indicators were used to enable an accurate monitoring of all major features of landscape change including changes in land use, landscape structuring, habitat settings, and urban sprawl.

According to our first results, the South-Tyrolean municipalities in the Upper-Vinschgau valley-bottom are increasingly forced to cultivate permanent crops. Contrary to this, the municipalities in the Lechtal in Western Tyrol are challenged with depopulation and an abandonment of agricultural areas.

According to the Degree of Naturalness (N_d), one of the applied indicators, naturalness is increasing after abandonment of agricultural areas. On the other hand, it is decreasing, if agricultural use is intensified which leads to a decrease in diversity, too. Up to 16% less land-use diversity due to intensification in the valley floor has been observed in one of our South-Tyrolean study areas. Contrary to this, the abandonment led to an increase in diversity by 19% in Lechtal (Western Tyrol). In spite of the different agricultural land-use development, an enrichment with structuring elements such as groves or hedges has been recorded both for intensification (+3,8%) and for abandonment (+6,5%).

Quantitative analysis in combination with qualitative results from our ongoing project, including interviews with stakeholders and farmers, will be used for creating landscape scenarios in our model regions.

E3-O3: Forest-avalanche feedback effects under environmental changes in the Swiss Alps

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In the Swiss Alps, agricultural land abandonment has led to an expansion of forests, even though agriculture is highly supported by the Swiss government. To close this gap between political goals and reality, agricultural support in Switzerland will be revised by 2014. The ensuing changes in land use, combined with climatic changes, will influence forest extent and structure, and hence also ecosystem goods and services provided by forests.

Snow avalanches are a main disturbance factor in the Swiss Alps, influencing forest dynamics at high altitudes. Additionally, forests can influence avalanche release probabilities, leading to feedbacks between forests and avalanches. Under the influence of environmental changes, these feedbacks can make management of protection forests difficult. Our goal is to investigate the feedback properties, the influence of land-use and climatic changes, and the potential consequences for future land management. Dynamic models capable of simulating the feedback processes, including influences of environmental changes, are suitable tools to study the future development of feedbacks and to provide normative scenarios for forest and land management. Therefore, we coupled the forest-landscape model TreeMig to a new avalanche model to simulate forest and avalanche dynamics in future centuries under different land-use and climate change scenarios.

Our results revealed that a three-way interaction between topography, climate, and land use influences the forest and its protective function. In potential avalanche release areas, the forest density required for protective function depends on slope steepness, while the time until protective function is reached again after disturbances depends on climate and land use. The influence of this three-way interaction on forest-avalanche feedbacks, and on future land management decisions, is discussed for Davos, a municipality in the eastern Swiss Alps.

E3-O4: Of alpine botanists and plants: long-term changes of summit plant diversity

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To study the frontiers of plant life in the nival zone, botanists with mountaineering skills have centuries ago climbed many high summits in the Alps. These researchers have collected a wealth of data on the flora of more than 250 summits in Switzerland alone, and many more worldwide. Such data is ideally suited to study long-term vegetation changes in high altitudes and their driving factors. Meanwhile, not only the climate has warmed considerably, but also land-use, the population sizes of wild animals and hikers have changed.

In our study, we re-visited and botanized 150 summits in the Swiss Alps. Species richness has increased considerably during the past 100 years. Factors that promoted this increase were a relatively low altitude of summits, mixed geology and a high number of herbivores, while human disturbance tends to have had a negative effect. The increase in species numbers has been accelerating since the first summit studies in the 1980ies, parallel to a stronger temperature increase. Many summit colonizers are species typical of lower areas, but some characteristic high-alpine species became even more frequent as well.

Our results confirm that climate warming shifts plant species distribution limits upwards and thus, drives the overall pattern of floristic enrichment on alpine summits. However, whether a species can reach a summit and persist there also depends on other factors, such as local environmental conditions, seed vectors, and human disturbance.

Poster Presentations

E3-P1: Landscape effects on local grassland plant diversity in Eastern Europe

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Local species assemblages are often affected by their surrounding landscape, e.g. through their connection to populations in other habitats. These landscape effects have been demonstrated for several animal taxa, however, despite being key elements for biodiversity and ecosystem functioning less is known about the effects on plant communities, and existing studies show contradictory results. In this investigation, the extent to which the surrounding land-use affects local plant diversity will be investigated for traditional low-land large-scale grazing pastures in Transylvania, Romania. Within the study area, agricultural landscapes with a long history of low intensity management are starting to be transformed by intensification and abandonment. This study therefore aims to determine to what extent these land-use changes in the surrounding areas may impact on the high plant diversity and rare species found within the pastures. Here, the project concept, background, and initial findings will be presented.

E3-P2: Dynamics of landscape structure and land use in Mleta (Greater Caucasus, Georgia)

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Changes in landscape structure and land use result from complex interactions of natural and human-induced environmental (such as soil erosion and land degradation) and socio-economic processes (such as pauperisation and migration) at spatio-temporal scales. The analysis of historical land-cover and land-use changes can contribute to a deeper understanding of human-environment interrelations and thus to the development of sustainable land-use strategies. In our work, we focus on (i) quantifiying changes in landscape structure and land use in the region of Mleta, a marginal landscape in the Greater Caucasus of Georgia, (ii) identifying the environmental and socio-economic drivers of change in this landscape, and (iii) understanding the interrelations between the driving forces. The study is, on the one hand, based on data stored in a GIS (e.g., aerial images from 1958, 1971 and 2005) and, on the other hand, on field data and information from local people. In the poster, we will present first results of the combined analysis of the different databases. Our work is part of the research project amies (Analysing multiple interrelationships between environmental and societal processes in mountainous regions of Georgia; www.amies-net.org).

E3-P3: Employing vegetation databases to analyse land-use change in a Caucasus region

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The Caucasian Republic of Georgia, is an international biodiversity hotspot. Since independence in 1991, the country has, however, experienced dramatic transformation processes. Land privatisation and the alteration of land management have caused environmental problems such as land degradation, deforestation, soil erosion and biodiversity losses. These resulted in impoverishment and depopulation. Climate change aggravates the environmental problems. Knowledge to support sustainable land use and land development is hence urgently needed. In this context, the VW-foundation's 'amies' project (www.amies-net.org) focuses on an interdisciplinary Georgian / German multi-scale research approach.

The classification of land use patterns and the reconstruction of their temporal and spatial changes in the alpine Kazbegi District (Greater Caucasus, altitude 1700 – 5000 m) is one major aim of the project. Methods include remote sensing approaches and multi-temporal image interpretation. Field vegetation data is however needed to understand the links between land management (changes) and the diversity of montane to alpine grassland vegetation.

The species-rich grassland vegetation of the central Kazbegi region has been extensively sampled by Georgian botanists for the past 40 years. The resulting 500 vegetation relevés were stored in archives but were not available in electronic form. In a first step of the 'amies'-project, these relevés were digitized and supplemented with another 150 relevés sampled in 2010 and 2011. Around 300 historic relevés had spatial references, these could thus be combined with available spatial data (DEM, land cover) and used for landscape analysis. Ordination techniques were applied to disentangle the ecological patterns of species distribution with respect to land use and physical attributes.

E3-P4: BIO-CHANGE of deciduous forests over the last 40 years

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We studied vegetation changes of deciduous forests over the last 40 years. Our study is part of the Bio-Change project within the initiative of excellence by the federal government of Lower Saxony. We repeated 200 relevés recorded in 1970 from deciduous forests on sandstone and limestone in south Lower Saxony and compared diversity and composition of former and recent vegetation using ordination techniques and analysis of variance. In both forests types there were considerable changes in vegetation composition. Indicator species for nutrient poor (e.g. *Leucobryum glaucum*, *Luzula luzuloides*) and bright and dryer conditions (e.g. *Galium sylvaticum*, *Poa nemoralis*) decreased while indicator species for nutrient rich (e.g. *Allium ursinum*, *Urtica dioica*) and dark conditions (several fern species) increased. In addition the neophyte *Impatiens parviflora* increased considerably. In total, in forests on sandstone changes were stronger than in forests on limestone indicating a more sensitive system regarding the responsible factors. We conclude that emissions of atmospheric nitrogen which had been rather high in the time of our study display a major factor for vegetation change. In addition, in the forests on limestone the management of the forests appeared to change stronger, i.e. from a coppice forest to a full-grown tree forest resulting in a higher proportion of beech and thus darker conditions.

E3-P5: Bio-change in flowing water vegetation in NW-Germany over the last 60 years

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We studied changes in diversity and composition of macrophyte vegetation of flowing waters in north-west Germany (Lower Saxony and northern North Rhine-Westphalia) over the last 60 years. Our study is part of the Bio-Change project within the excellence initiative by the federal government of Lower Saxony. In 2010–2011, old relevés from the 1940–1960ies at 58 rivers and rivulets were repeated and diversity and composition of vegetation of both periods were compared. In addition, structure of flowing waters and habitat type of adjacent crops have been studied. Our comparison reveals a dramatic loss of macrophyte diversity and a shift in species composition in favour of common macrophyte species. Neophytic macrophytes and indicator species for eutrophic conditions increased considerably while indicator species for oligotrophic conditions decreased. The structure of flowing waters was considerably more diverse in the 1940–1960ies while recent habitat structure of flowing waters is quite uniform. We conclude that restoration measures in northern German flowing waters and reintroductions of macrophytes are urgently needed.

E3-P6: Effects of habitat isolation and -composition on control of *Myzus cerasi* over time

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Ecosystem services such as pest control can be negatively influenced by habitat fragmentation. Aphids are major pests on a wide range of plants. Aphid density is known to be reduced by several predators and parasitoids. On the contrary, aphid tending ants can enhance aphid densities. We tested the effects of habitat isolation and landscape composition on interactions around the black cherry aphid (*Myzus cerasi*). We established 30 groups of young cherry trees near Bern, Switzerland. Our study sites had three different levels of isolation from woody habitats and independently varied in the amount of forest in the surrounding landscape. We

followed the colonization of the trees by arthropods for three years. Besides observations of natural populations of arthropods and their eggs we also established standardized aphid densities on some of the trees.

We hypothesized that (i) negative effects of habitat fragmentation increase with trophic level and that therefore (ii) aphid suppression decreases with habitat fragmentation. Preliminary results indicate that already after two years the effects of habitat fragmentation change according to arthropod functional groups. Consequently, the effects of habitat fragmentation on aphid suppression change over time as well.

E3-P7: A quantitative review of the ecological impacts of the Chernobyl disaster

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Nuclear energy is one potential solution to rising electricity demand. However, nuclear energy clearly entails risks, as highlighted by incidents and accidents recorded worldwide. Policy debates on the consequences of nuclear accidents and incidents have first and foremost focused on direct negative impacts on humans. Despite such impacts being clearly of high relevance, we argue that policy debates must likewise take the ecological consequences of nuclear accidents into account. In order to provide an overview of the ecological consequences of nuclear accidents, we reviewed a total of 524 studies conducted after and focussing on the Chernobyl accident, which occurred in 1986 and until recently had been the most catastrophic and well known nuclear accident. Following this major accident, highly elevated radiation levels have been recorded in many species and parts of the ecosystem, up to thousands of kilometres from the accident site, and still more than two decades after the meltdown. Furthermore were ecological consequences recorded, which especially close to the accident site include physiological and morphological changes, with mostly unknown consequences for evolutionary trajectories. Valued ecosystem services also have been negatively affected, including many sources of water, agricultural crops and wild foods contaminated and vast landscapes rendered useless for decades. Wise policy decisions on nuclear energy demand a better understanding of the uncertain and potentially disastrous consequences of nuclear accidents on ecosystems.

E3-P8: Ecological data interpretation of a regional flora project

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Results of floristic mappings do not only provide information about the distribution of taxa, but also allow further ecological and biogeographical interpretations. Data from grid system mappings are particular appropriate for a computer aided analysis.

Some examples of such an analysis are presented at the poster. The underlying data originate from the floristic mapping project of the Elbe-Weser-area (NW-Germany, ca. 8450 km²), for which a distribution atlas has been published recently (Cordes et al. 2006). For this atlas the occurrence of nearly 1200 plant taxa (vascular plants) has been documented between 1983 and 2004 at a quite fine grid scale (1192 grid cells, each with a size of about 2,8 x 2,8 km²).

The overlay of ecological and biogeographical classification data and abiotic data allows to answer several questions. Are abiotic patterns of the study area reflected by the distribution patterns, or is the used grid scale to coarse? Where are the most species rich areas? Are there indicator species for high phytodiversity? Is a biogeographical differentiation of the study area indicated by plant distribution patterns?

E4 Biodiversity patterns at different scales - from theory to application

Oral Presentations

E4-O1: Do we have a consistent terminology for species diversity? We are on the way.

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A consistent terminology for species diversity is subject of an ongoing debate. Recently Tuomisto (Oecologia 164:853–860, 2010) stated that a consistent terminology for diversity already exists. The paper comments on recent papers by Jurasinski et al. (Oecologia 159:15–26, 2009) and by Moreno and Rodriguez (Oecologia 163:279–282, 2010). Both started from Whittaker's diversity concept to discuss the ambiguities of the terminology and propose a new, more consistent terminology that bases on the different approaches to diversity analysis. In contrast, Tuomisto adheres to a strict school of thinking and derives a diversity framework in the sense of Whittaker (alpha, beta, gamma) from the conceptual definition of diversity itself.

In the presentation a comprehensive terminological framework for the quantification of species composition and diversity will be developed and explained. It embraces the strict definition of diversity levels as well as the many approaches to beta that have been used so far. All approaches to the analysis of species composition and diversity can be assigned to three abstraction levels (species composition, variation in species composition, variation in variation in species composition) and two scale levels (sample scale, aggregation scale). Methods that investigate the variation in species composition across scale levels evaluate beta relation. Beta diversity is just one form of beta relation, and is calculated by dividing gamma diversity of order q by the appropriate alpha diversity. In contrast, differentiation refers to a pairwise calculation of resemblance in species composition. It is restricted to sample scale and is therefore most often only an intermediate step of analysis. Many ecological questions can be addressed by further analyses of differentiation data sets and many known numerical methods fall into this category.

E4-O2: Distance-decay in compositional similarity depends on study extent and plot size

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The relationship between geographic distance and similarity in species composition is regularly used as a measure of species turnover and beta diversity. Distance-decay analyses are applied, cited and compared over several spatial scales. In addition different sized plots (like islands or states) are regularly used within such analyses, implicitly assuming that the distance-decay relation is independent from plot size. We use an artificial one dimensional "landscape" to show that the slope and goodness of fit measure R^2 of the distance-decay relationship is influenced by plot size and extent of the study. A comparison between different studies must thus be done with caution or be restricted to those cases where sampling scale and pattern is constant.

We illustrate such an example by comparing the distance-decay relation of an area dominated by agriculture in southern Germany with a nearby semi-natural military training area that is not exposed to agricultural use. While distance decay is still present in the semi-natural area, no distance decay was found in the agricultural area in close proximity. It is likely that the human disturbance regimes in the agricultural landscape dominates over niche processes as a driver of beta-diversity.

E4-O3: GBIF-D: 10 years of contributing to the Global Biodiversity Information Facility

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Global Biodiversity Information Facility (GBIF) has the mission of mobilizing the world’s primary biodiversity data via the Internet. Germany was one of the founding members in 2001 and the Federal Ministry of Education and Research (BMBF) and the German Research Council (DFG) today share the German contribution to the GBIF Secretariat in Copenhagen. A first BMBF-funded project phase (2001-05) was aimed at implementing the technical network and establishing a decentralized structure within the German research community. Activities ranged from exemplar digitization (e.g. zoological type specimens) and centralized storage to fully distributed networking of institutional databases holding specimen and observation data. One of the technologies used in the global network was developed in Germany within the EU-funded BioCASE project (BiologicalCollectionAccessService for Europe), and so was the international data exchange standard ABCD (Access to Biological Collection Data). In September 2004, 40 countries and 26 organizations contributed more than 43 million occurrence records from 82 providers. In April 2011 there are 56 countries and 47 organizations participating. More than 300 publishers contribute in excess of 267 million records from over 12,000 datasets, among them 7.4 million records from Germany. These data span a wide range of geospatial and temporal occurrences and taxa. Since the end of 2010 GBIF-D (www.gbif.de) is again funded as a 3-year project by the BMBF (01LI1001A-F). Harnessing the experience gained during the first 10 years of GBIF, the German node system will be technically modernized, data contributions will be extended, and the community of data providers and users will be broadened. Combining and globally sharing all available biodiversity data is a remarkably complex task - but considering the huge gaps in knowledge that still exist, jointly tackling this task is absolutely essential to solve the growing environmental crises.

E4-O4: A decade of standardized biodiversity observation in Africa - methods and lessons

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Due to global losses of biodiversity there is a great need to develop adequate methods to measure the quality and quantity of biodiversity change, encompassing a wide range of scales, groups of organisms, environmental factors, in a wide range of ecosystems. The global dimension of the change of biodiversity also calls for harmonized approaches in order to contribute to the Global Biodiversity Observation Network GEO BON in the frame of GEOSS. In the context of the international, interdisciplinary biodiversity research project BIOTA AFRICA a standardized biodiversity monitoring method has been developed and tested in a wide range of major terrestrial ecosystem types along climatic gradients across the African continent over nearly a decade (2001-2010).

BIOTA long-term monitoring sites ("Observatories") have been established along climatic and landscape gradients in Morocco, West Africa, and southern Africa. In regions with varying land use, several BIOTA Observatories are situated close to each other to analyze management effects.

Besides long-term monitoring of biodiversity itself, also measures of potential drivers of the change and related indicators with adequate spatial and temporal resolution have been integrated. A very high degree of standardization allows integration and comparison of data generated by many scientific disciplines within different ecosystems. In order to allow spatial up-scaling each BIOTA Observatory encompasses an area of 1 $km^2$and is subdivided into 100 1-ha plots. For meeting the needs of sampling of different organism groups, the hectare plot is again subdivided into standardized subplots, whose sizes follow a geometric series.

Based on the (mostly published) results of the project it is now possible to critically review the methodological approach, to identify problematic impediments and to derive some recommendations for future research activities.

E4-O6: How (not) to incorporate biotic interactions into species distribution analyses

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Statistical analyses of species' presence-absences usually do not include biotic interactions. We briefly review the approaches currently available to do so, before comparing their results for a data set from the Wadden Sea. Three different approaches have been proposed to incorporate biotic interactions: 1. including presence-absence or abundance data of the interacting species as a predictor; 2. doing so for all interacting species simultaneously, thereby creating a system of coupled regressions; 3. indirectly coupling spatial regression models through their spatial autocorrelation term. Methods 1 and 2 suffer from fundamental problems of misspecification and ill-posedness of the problem. Method 3 is statistically sound, but whether its indirect approach is sufficient to model directly occurring interactions is currently unclear. Using a fine-scaled point-sample data set of over 2000 observations from the Dutch intertidal, we compare the fits of the three approaches, their estimates for the effects of both biotic and abiotic predictors, and evaluate the ecological plausibility.

E4-O7: Diverse communities function for longer due to turnover of dominant species

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Whereas higher biodiversity has been shown to increase ecosystem functioning, studies also indicate high redundancy between species. Here we show that this apparent redundancy is substantially reduced if we consider the maintenance of functioning across time. Across seven years in a large biodiversity experiment, more diverse plant communities were functional—i.e. produced biomass above a certain threshold—for a longer time, and both species richness and functional group richness were important in increasing functioning over time. Within communities substantial turnover occurred between the dominant species driving biomass production and this was greater the longer the timescale, the more species rich the community, and the more even the species abundances within a community. Higher species turnover within communities increased their biomass production over time, but only in those communities with higher functional diversity: suggesting that complementary interactions between functionally dissimilar species maintained functioning over longer time scales. Our results strongly reinforce the argument for conservation of high biodiversity.

E4-O8: Long term dynamics of a vascular epiphyte assemblage in a lowland rainforest

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Tropical forests are the most diverse terrestrial ecosystems, and knowledge of structure and dynamics is essential in the context of conservation and global change issues. However, while long-term studies of tree communities have become more available, knowledge of a similarly diverse system, such as vascular epiphytes remains scarce.

Vascular epiphytes are closely linked to tree community dynamics since they are directly affected by tree growth and mortality. The nature of this interaction depends on scale, changing from individual tree to the local population of a tree species, to all trees in a local patch of forest. In this study, we followed the structure and composition of an assemblage of epiphytes on the tree species *Socratea exorrhiza*, in c. 1 ha of lowland rainforest in Panama over a period of 10 years.

Host availability and colonization consistently decreased until the 5th census, at which point they began to increase; resulting in an overall increase in colonization (10%), even when the number of palms remained reduced. Epiphyte abundance increased significantly over time and

the number of species did not vary greatly among censuses. The increase in abundance influenced the structural dynamics of the assemblage. While some of the most abundant species switched their abundance rank gradually but not significantly, thus showing some temporal fluctuation, some low- and medium-frequency species showed a consistent increase or inconsistent fluctuation.

Overall diversity was maintained with a rather high rate of replacement, especially for fast-growing species, and overall abundance increased more than twofold. In conclusion, while there is variation in the relative abundance in time, the core of the most abundant species remained stable. A future expansion of the study, through inclusion of different host tree species, will allow further analyses at a larger spatial scale.

E4-O9: Global warming: A centennial assessment of shifts in arthropods, birds and plants

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A general upslope shift of elevation range caused by global warming has been demonstrated in many species. In order to deepen our understanding of the biological processes behind the impact of global warming, an integrative examination of taxonomical comparisons and trait-specific analysis of species' response is necessary. To this end, we used data on the upper distributional range margin of two orders and one family of insects (Coleoptera, Hymenoptera, Syrphidae), and of birds and plants from two distinct time steps 1895-1904 and 2006-2007, for the same low range mountain in South-eastern Germany along an elevation gradient of 850m. Mean annual temperature increased between the two periods from 5.05 to 6.23°C due to global warming. We therefore predict an upslope shift of 200m for the species under study, due to the regional lapse rate of 0.59 °C per 100m. Consistent with this prediction, we found upslope range shifts for all three arthropod lineages, but not for plants and only a weak upslope range shift for birds. Furthermore, consistent with the 'thermal melanism hypothesis', we found a significant decrease of melanism in beetle communities at elevations >1000m between both surveys. Our results therefore support the view that mobile ectothermal arthropods show a direct response to climate fluctuations, but not birds and plants. Furthermore, these observations underpin that currently, communities are undergoing a process of reorganization in their species compositions, which changes present community classifications.

E4-O10: Area and heterogeneity as drivers of species richness in forest patches

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It is a widely accepted fact in ecology that species richness increases with area. However, the ecological explanation of this general phenomenon is subject of ongoing debate. In particular, increasing site heterogeneity ("habitat diversity hypothesis"), area dependent immigration and extinction rates ("area per se hypothesis"), and sampling effects are discussed as possible explanations for the positive richness-area relationship.

The present study focuses on disentangling the effects of heterogeneity and area on species richness of different groups of vascular plants in isolated patches of eutrophic deciduous forests in NW-Germany. Additionally, connectivity and habitat continuity were considered as possible drivers of species richness. We used structural equation modelling to partition joined and specific effects of these drivers.

Overall species richness is only related to area, but results indicate no significant specific effect of heterogeneity. However, species groups react very differently:

- Forest species in general are significantly affected by both, area and heterogeneity, with a greater partial influence of heterogeneity.

- Richness of those forest species confined to eutrophic deciduous forests is particularly affected by heterogeneity with no additional effect of area. This is the only species group where connectivity has a significant influence.

- On the other hand, species occurring both in forests and open habitats react solely on area with no specific effect of heterogeneity.

- Richness of open habitat species is positively related to area but even negatively affected by site heterogeneity.

An analysis of species groups based on CSR strategy (Grime 1974) revealed that richness of species with predominant S strategy is affected by heterogeneity with no specific effect of area and additionally by habitat continuity. Species with C and R strategy are only influenced by area with no additional effect of other drivers.

We conclude that while area is the dominant driver for overall species richness of eutrophic deciduous forests, the habitat diversity hypothesis especially holds for the specific flora of this forest type.

E4-O11: 90 x 90m is an optimal spatial scale to study the habitat use by hazel grouse

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This study reports an analysis at three different spatial scales with the aim at identifying the most explicative scale to investigate the role of management, stand structure and ground layer on the habitat of hazel grouse (*Bonasa bonasia* L.).

Three locations with increasing density of nesting sites were selected in the Trudner Horn Park, Bozen Province (Northern Italy). In each site a lattice regular grid of 100 30×30m cells was sampled, providing that it contained at least one nesting site. Within each cell we drew two orthogonal transects. On each 1m segment we recorded herbaceous and canopy cover and we counted hazel grouse presence indices. On each 5m segment we recorded stand structure. In the whole cell we measured woody species cover and top height, evidence of cuttings, *Rufa* ant nests and other management variables.

The effects of management, stand structure and ground layer sets of explanatory variables on presence/absence and on the count of presence indices were analyzed using generalized linear mixed models (GLMM). Separate GLMM analyses were performed within each of the three sets of variables and for each spatial scale (1×1, 2×2 and 3×3 grid cells). The significant variables were then further analyzed by variation partitioning (VP) to determine the unique and joint fractions of variation explained by the variables for each spatial scales.

At the largest spatial scale both the presence/absence and the count models showed higher explained variation (88-43% respectively) than at small (19-10%) and intermediate (63-40%) spatial scale. While the pure effect of single sets of explanatory variables could be higher at smaller spatial scale, the joint variation shared between the three groups was the highest in the 3×3 grid cells (90×90m) scale, where the largest part of the explained variation in the presence/absence model was related to joint variation between ground layer and stand structure (30%) and between the three groups (29%).

E4-O12: Can diversity measures help to characterise land-use effects in arid systems?

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Rangeland grazing by domestic livestock is the most important type of land use in arid and semi-arid ecosystems. Much has been debated about the varying influence of grazing intensity on plant diversity in systems differing in climate, productivity and their evolutionary history of grazing.

To identify the effects of grazing on biodiversity, two aspects need to be considered: (i) the spatial and temporal scale at which these effects become apparent, whereof the latter is of special importance in temporally variable systems like (semi-)arid environments; and (ii) the use of appropriate diversity measures that can serve as indicators for changes in grazing intensity.

This study is based on vegetation monitoring data of three pairs of BIOTA Biodiversity Observatories (www.biota-africa.org) situated along a climatic gradient in (semi-)arid Karoo ecosystems ranging from summer rainfall Namibian savannas to winter rainfall dwarf succulent shrublands in South Africa. Each pair was characterised by profound differences in grazing intensity visible by a pronounced and temporally stable fence-line contrast. We analysed differences in plant species diversity using numerous diversity measures from different categories, i.e. α- and, β-diversity as well as functional diversity, and applied them at different spatial and temporal scales.

Due to the different degradation states in the studied systems, measures based on species numbers (e.g. species richness) did not consistently account for land-use effects on plant diversity. Our findings further suggest that within each of the different diversity categories, cover-based measures tended to be better indicators. We conclude that the (semi-)arid conditions and a relatively long history of ungulate grazing in the whole study region has selected for a large number of opportunistic species showing wide variations in abundance, yet persisting under different grazing regimes.

E4-O13: How to estimate plant species richness at a medium scale of 1 km?

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Many plant divems use plot-based sampling schemes. The determining plant species richness at different spatial scales is a major goal of biodiversity research. Extensive knowledge at medium spatial scale ranging between 1,000 m^2 and 100 km^2 is of special interest since most of nature conservation and land use decisions are made at these scales. Due to limited resources, scientifically proven methodology is needed to give justified richness values with low sampling effort and suitable extrapolation methods.

We tested the reliability of five extrapolation methods commonly used in biodiversity studies to estimate species richness for 1 km^2: (1) the number of actually sampled species, (2) extrapolation of species-area relationships (SAR), (3) extrapolation of species-sampling relationships (SSR), (4) non-parametric estimators, and (5) up-scaling with an universal species-area curve (Harte et al. 2009). We applied 12 different mathematical models to describe SARs and six models for SSRs. Four non-parametric estimators were calculated.

Sampling was conducted in a semi-arid savannah ecosystem of central Namibia at two BIOTA

Biodiversity Observatories (Narais and Duruchaus, Jürgens et al. 2011). In 40 randomly selected plots we sampled all vascular plant species in a nested-plot design up to 1,000 m^2.

We found a wide range of estimates between 127 and 355 species at Duruchaus and 124 and 347 at Narais. Highest values were observed for SARs described by power functions and generally lower values for SSRs and richness estimators. The universal species-area curve resulted in lowest estimates, even lower than the recorded richness (170 at Duruchaus and 145 at Narais).

Our findings suggest the application of a multi-methodological approach for extrapolation in biodiversity research and further examination of these methods with field as well as with simulation data.

E4-O14: Spatial scale dependency of local plant species diversity - topography relations

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Which factors and at which spatial scale these affect biological diversity is a central question in ecology. Broad-scale (global, continental) variation in biodiversity has been explained by among others topographic relief (elevation range): high mountains are thought to hold a number of climatic zones and hence more species than a relatively flat area. However, each plant individual in an area depends on its local microenvironment as well, and many aspects of this seem to be strongly related to local-scale topography and associated environmental factors, e.g.: soil characteristics, water balance, solar irradiation, and wind exposure. At even very small spatial scales (a few cm) topographic heterogeneity has been demonstrated to be of high importance to species richness in various communities. In this study we derived a number of topography-related variables, among others wetness, wind exposure, and solar radiation, from a new national digital elevation model (DEM) in 1.6-m resolution covering all Denmark. The same variables where derived from aggregated versions of this DEM in 10, 50, 100 and 250-m resolutions. Along with plant species abundance data from vegetation plots from the national NATURA 2000 monitoring program we assessed the importance of topography for plant diversity and vegetation patterns in a number of different habitat types throughout Denmark (~30000 plots distributed among ~970 sites) using advanced spatial statistical modelling. Moreover, by creating models at the aforementioned resolutions we further investigated the extent to which spatial scale was important for the modelling results and at what spatial scale the modelling yielded the strongest relationships between the topography-related variables and vegetation.

E4-O15: Spatial and taxonomic determinants of abundance in UK butterfly populations

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The factors that influence population abundance vary at spatial, temporal and taxonomic scales. Understanding the relative importance of these factors is a fundamental question in ecology. We present analyses exploring the components and correlates of abundance variation among 10,000 populations of 46 butterfly species, using data from the UK Butterfly Monitoring Scheme. We find that variation among species is important, but small in comparison with the genus and subfamily components (indicating a strong phylogenetic signal). Abundance variation in space is also substantial, but smaller than the taxonomic component. We then tested a suite of hypotheses for this variation, using linear mixed-effects models and multi-model inference. Important correlates of population abundance include site-level, species-level and population-level traits. Abundance is generally higher in species with narrow distributions and slow larval growth; at sites with many species and low average temperatures; and in populations close to the core of the range. We find no correlation between species' niche breadth and average abundance. However, interpreting these results is complicated by latitudinal gradients in occupancy, niche breadth, temperature, species richness and population stability. These factors imply that many correlations with abundance are likely to be dependent on the spatial and temporal scale of enquiry. We explore whether insights from 'unified' theories of biodiversity can help reconcile these issues.

E4-O16: Scale-dependent patterns of vascular plant diversity in southern Africa

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We studied patterns of vascular plant diversity at different spatial scales (100 m², 1000 m², 1 ha and 1 km²) from northern Namibia to the Cape of Good Hope in South Africa, covering six biomes and a steep rainfall gradient (see also Schmiedel et al. 2010). For the analyses, we used the diversity data sampled on the 37 standardised BIOTA Biodiversity Observatories arranged along the BIOTA Southern Africa transects (Haarmeyer et al. 2010; Jürgens et al. in press). We analysed family richness, species richness, as well as *z*-values (i.e. the slopes of power-law species-area relationships as measures of β-diversity) on all these spatial scales. We related the biodiversity parameters with regressions to potential drivers such as geography, land use, climate, and soil. The mean species density along the transects was 23.9 species for 100 m², with an absolute minimum of 0 (Desert Biome) and an absolute maximum of 128 (Fynbos Biome). The mean value for 1000 m² plots was 40 species (maximum: 169; Fynbos Biome), and 159 species (maximum: 385; Fynbos Biome) at the 1 km² scale. The following environmental factors showed the strongest relationship with species richness at the 1000 m² scale: mean annual precipitation (positive), precipitation seasonality (winter rainfall >> summer rainfall), mean annual temperature, length of dry season, and median pH values (all negative). The

complex-factor soil ecotype richness, as an expression of the variability of plant-relevant soil features per 1 km², was only related to species richness at the 1 km² scale. Spatial species turnover (expressed as z-values), was highest in the arid parts of the transect (Desert and Succulent Karoo) and lowest in the Fynbos Biome. We will discuss the role of the various drivers of plant diversity at different spatial scales along the transect and relate them to previous studies on regional and global plant diversity patterns.

Poster Presentations

E4-P1: Spawning site selection of anurans in a dynamic floodplain

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Temporal patterns of spawning activity and calling behaviour are already well described for European amphibian species. Beside the temporal differences in behaviour, spatial components influence spawning site selection of amphibians. Discussions and studies about meta-communities or niche patterns of amphibians increased during the last decade with increasing possibilities in modelling and statistic analyses. In Central Europe, these studies are mainly done in static landscapes and with common species but rarely in dynamic landscapes like floodplains, even though these are important primary and secondary habitats for amphibians. One reason might be that there are only few dynamic and hence natural floodplains left in Central Europe.

The study presented here took place in one of the most natural floodplains in Germany, the Middle Elbe River in Saxony-Anhalt. Calling behaviour and spawning site selection of the native and threatened amphibian species *Bombina bombina*, *Rana arvalis* and *Pelobates fuscus* were investigated from March to July in 2010 and 2011. Habitat analyses were done with the program R to identify environmental parameters that influence presence and abundance of the species at the patchy distributed waterbodies within the heterogeneous landscape. Cluster analyses and Regression trees were used to reduce dimensions of variables and regressions were done with approaches for zero-inflated data. The results show that the species have different preferences of habitat structures e.g. in vegetation structure or water chemistry of the water bodies . This supports the hypothesis of the nestedness of amphibian species in floodplains.

Information about preferred habitat structures contributes directly to floodplain landscaping to improve amphibian habitats.

E4-P2: Island-mainland plant communities: drivers of spatial components of diversity

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Conserving biological diversity has been internationally accepted in the scientific community and in governmental programmes (e.g. Convention of Biological Diversity 2010), but definition and assessment of biodiversity are highly depending on spatial and temporal scales. Ecologists have introduced the concept of species diversity at multiple spatial scales in a landscape (i.e. *alpha* and *beta* diversities). However, functioning and interactions of driving factors such as regional species pool size, site productivity and disturbance are only sparsely investigated on different spatial scales and therefore poorly understood.

In this new project we plan to address the role of large herbivores (sheep and reindeer) for the spatial organisation of plant species diversity (*alpha* vs. *beta* diversity) in relation to site productivity within the low arctic-alpine environment and assess the effect of regional species pool size by comparing study sites in Iceland and northern Norway. In addition, we will test the influence of including cryptogams (mosses and lichens) in species diversity measures on spatial patterns of diversity in Iceland.

We will assess spatial patterns of plant diversity according to a spatial hierarchical design, which includes five nested scales from local to regional, i.e. plot, gradient, sites, landscape area and district. Districts representing *different grazing intensities* will be selected in Iceland (*relatively small species pool*) and Finnmark, Norway (*relatively large species pool*). Diversity sampling and assessment of *siteproductivity* (measurements of NDVI and soil characteristics) will be conducted on plot level (40x40cm).

E4-P3: Free access to biodiversity data? How to contribute to GBIF - and why

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The Global Biodiversity Information Facility (GBIF) is an international initiative of 56 countries and 47 organizations. GBIF has the overall mission of mobilizing the world's primary biodiversity data via the Internet. The GBIF network currently provides access holding more than 276 million records. GBIF was established in 2001 and Germany is one of the founding nations. Currently GBIF Germany (GBIF-D, www.gbif.de) is funded as a 3-year project by the Federal Ministry of Education and Research (BMBF, 01LI 1001 A-F).

Eight institutional nodes form the backbone of GBIF-D. The BGBM Berlin-Dahlem is responsible for coordination as well as for plants and protists; the German Collection of Microorganisms and Cell Cultures in Braunschweig for bacteria and archaea. In Munich, the Botanische and the Zoologische Staatssammlung are in charge of fungi, lichens and invertebrates (molluscs and myriapods), respectively. The Museum fuer Naturkunde in Berlin is responsible for insects and fossils, Senckenberg in Frankfurt for invertebrates (marine invertebrates) and the Forschungsmuseum Alexander Koenig in Bonn for vertebrates.

Main objective of GBIF-D is the mobilization of suitable data from Germany's research community, focussing on "species occurrence data", i.e. specimens and observations. In addition, GBIF-D offers expertise on technical aspects of data capture and database networking. Stable workflows to support the provider from data entry to open and free online access are established. Managing the sharing of global biodiversity data is a complex task – but absolutely essential to solve the growing environmental crises.

GBIF is far more than the mobilization of natural history collections data. We will call on the scientists present to integrate their data into the GBIF network and to start using GBIF data for their own work, in order to benefit from the global effort GBIF represents.

E4-P4: Plant endemism in Europe: Spatial distribution of endemic vascular plants

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To face up to the biodiversity challenge and thus to span a systematic and tight conservation net which will help to prevent species loss, it is necessary to focus on species which have a restricted range size. The present study provides a general overview of endemism of vascular plants on the European continent. It focuses mainly on the evaluation of endemism patterns from a geographical perspective (but floristic, taxonomic and ecological data were also evaluated). It is hypothesised that most of the variability in the data on Europe's botanical endemism can be well explained with the help of simple indices describing the explanatory variables species pool, regional habitat diversity, isolation degree and habitat continuity. The investigation is mainly based on the data of about 6,200 endemic vascular plants listed in the database EvaplantE (Endemic vascular plants in Europe). The endemism data was combined with geographical datasets and visualised in digital maps using GIS applications. Several indices describing the explanatory variables were derived from digital maps by blending different thematic (map-)layers with the map of the study area. Due to the incidence of spatial autocorrelation, spatial accounting statistics, i.e. geographical weighted regression, were applied. The study shows a general gradient of plant endemism from north to south and also proves the importance of Europe's mountainous and isolated island regions with respect to endemic diversity. The influence of explanatory variables on the current spatial patterns of endemics was quantified: Patterns of local endemism were explained by isolation degree, species pool, and habitat diversity, while patterns of European endemics were explained using the explanatory variables species pool, and habitat diversity. It was shown that a spatial accounting regression method was able to incorporate spatial dependencies (spatial autocorrelation) and results in valid models (high pseudo-R^2).

E4-P5: Patterns of phytodiversity in forest openings of the Trascău Mountains (Romania)

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We compare the responses of α- and β-diversity of herbaceous species to environmental variables in forest openings of the Trascău Mountains, Romanian Carpathians. The sampling was conducted in 40 openings, using edge-to-interior transects composed of 1-m² plots. Grassland species were most numerous, followed by forest-edge and forest species. The results of the generalized linear mixed models (GLMMs) show that canopy openness (assessed using hemispherical photos) and tree litter cover were the primary variables that explained species richness at the plot scale. Tree litter cover (positive) and bedrock type (basic > acidic) explained the β-diversity within transects. The divergence in response reveals that the two biodiversity components are determined by different ecological processes. Conservation planning should aim at maintaining the current traditional forest management that creates openings and maintains a grazing regime within them.

E4-P6: How does sampling effort affect the completeness of vegetation surveys?

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Many plant diversity studies and monitoring programs use plot-based sampling schemes. The selection of appropriate plot size and shape depends on the requirements to answer the specific research question with highest accuracy and on the time and personnel resources of the project.

Only at smaller scales (ca. up to 1,000 m2) almost complete sampling of plant species seems to be achievable with reasonable resources, depending on the ecosystem concerned. To test the influence of sampling effort at larger scales, we conducted an extensive vegetation survey at ten 1-ha plots in a semi-arid savannah ecosystem in central Namibia with high temporal effort and a standardized sampling method. Since it is nearly impossible to attain a complete species inventory within any reasonable sampling time, we estimated the ‘true’ species richness at these plots by modelling species-time curves. With these estimates, we determined the level of exhaustiveness (Archaux et al. 2006) after a defined sampling time.

We compared our findings with the results of the regular vegetation sampling on the same plots conducted over the last five years with a less time-consuming methodology by the BIOTA monitoring program (Jürgends et al. 2011)

This procedure aimed at providing information on an appropriate sampling time effort to record a majority of species for a medium large plot size. Our results show that the application of species-time curves as richness estimators results in robust estimates which are suitable to analyse the exhaustiveness of the different sampling approaches within this study. The level of exhaustiveness proved to be a helpful instrument to gain information about the reliability of vegetation surveys and to provide comparability to similar studies.

E4-P7: Testing the existence of small island effects with a comprehensive dataset

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In island biogeography, Small Island Effect (SIE) denotes a situation when on small islands below a certain threshold size, species richness varies independently from island area. Recently, doubts on the existence of SIEs have been brought forward as many of the studies on the topic used inappropriate methodology, such as (i) excluding islands with zero species, (ii) not comparing all relevant models, or (iii) not accounting for different model complexities (see Dengler 2010). Therefore, we re-analysed the more than 100 island data sets that had been studied by Lomolino & Weiser (2001), for the majority of which these authors had claimed the existence of an SIE. We fitted different species-area models to these, namely the following six variants of the power-law and logarithmic functions: (i) linear (i.e. unmodified); (ii) quadratic; (iii) cubic; (iv) breakpoint with zero slope to the left (i.e. classic SIE model); (v) breakpoint with zero slope to the right; (vi) two-slope model. Fitting was done with non-linear regression, and the subsequent multimodel inference was based on AICc as goodness-of-fit measure. We will present how many of the data sets were inappropriate for testing for an SIE due to the ignorance of zero-species islands, and how frequently which of the species-area models performed best among the set of compared functions. We will discuss the consequences of our findings for the concept of SIEs and island biogeography in general.

E4-P8: Scale-dependent diversity patterns in Transylvanian dry grasslands (Romania)

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In the Transylvanian Lowland (Romania), extended dry grasslands still exist that are outstanding in diversity and conservation status compared to European standards. However, this treasure is not well documented so far. We sampled the whole range of Festuco-Brometea communities occurring in different sites (many of them within Natura 2000 sites) in Transylvania. We sampled nested-plot series with plot sizes ranging from 1 cm² to 100 m² as well as 10-m² plots in additional sites. In both cases, we recorded vascular plants, terricolous bryophytes, lichens, and "algae" as well as major environmental data (altitude, aspect, inclination, microrelief, land use, structural data) and measured fundamental soil parameters. We found very high species richness values at all spatial scales, e.g. if compared to similar dry grassland types in Germany. The highest species densities were recorded in meso-xeric hay meadows (Cirsio-Brachypodion). Maximum species richness values were 5 (with 5 vascular plant species) on 1 cm², 8 (8) on 10 cm², 19 (17) on 100 cm², 45 (43) on 1000 cm², 82 (81) on 1 m², 101 (99) on 10 m², and 131 (127) on 100 m². It appears that the values at 1000 cm² and at 10 m² are likely the highest ever recorded in any plant community worldwide. We applied generalized linear models (GLMs) with single and multiple predictors for total, vascular, and non-vascular species richness, and checked the residuals for spatial autocorrelation. Heat index was the best single predictor of 10-m² richness (negative). Mown grasslands were generally richest, followed by pastures, while plots in abandoned grasslands contained significantly fewer species. Further, we analysed species-area relationships, which were generally best described by power laws but with some interesting deviations.

E4-P9: Pond networks in agriculture-biodiversity interactions: a multi-scale approach

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Agricultural durability and biodiversity conservation are challenges that have long been considered separately as their objectives appear conflicting, especially regarding to agricultural intensification. However, nowadays, more and more studies examine ways to optimize the agriculture-biodiversity combination. In this respect, a historically recurring question has been to know at which scales we should tackle this problem.

For that purpose, ponds are an interesting case of study. They are important shelters of biodiversity at different scales; they as well ensure depollution functions and nutrient catchment which makes them relevant systems to investigate the agriculture-biodiversity combination.

According to this potential double-function of ponds, we want to investigate at which density of pond networks we could optimize both biodiversity levels and nitrogen retention, and at which scales addressing the problem.

For all this work, this first year of study, we started surveying 90 ponds in an intensive agricultural landscape characterized by cereal open-fields, in the department of Seine-et-Marne, France. These 90 ponds were selected so that they form different network densities, from one to six ponds per network. In each site, under a standardized protocol, we assess species richness and abundance for three functional groups: Amphibians, Aquatic Macro-invertebrates and Plants. Measures reflecting nitrogen retention are also conducted one time per season. Information about the surrounding crop practices will be after-acquired. We will consider multi-scale and spatial-explicit approaches as the response of biodiversity to environmental factors will be compared between three spatial scales: pond, network and landscape scales.

Here we aim at presenting our method and preliminary results about the scale-dependent link between pond network density and ponds biodiversity.

E4-P10: Global index of vegetation-plot databases (GIVD): a new tool for biodiversity research

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Vegetation-plot records, broadly defined as records of plant co-occurrence at particular sites, constitute the primary descriptive data on which much of vegetation science is based and serve as the single most important data resource available to vegetation scientists.

The data that became available during the last decades through vegetation-plot databases facilitated, inter alia, consistent large-scale vegetation classifications, macroecological pattern analyses, and the assessment of global change effects on vegetation. However, it was not easy to retrieve appropriate databases for such analyses, in particular at a supra-national level. Therefore, we compiled GIVD (http://www.givd.info), an internet-based resource aimed at registration of metadata on existing vegetation databases, co-ordinated by an international Steering Committee. GIVD contains descriptive data of vegetation-plot databases worldwide, such as scope of the database, owner and contact data, number, geographical and temporal distribution of the relevés, and environmental data available for these.

Since its launch in autumn 2010, more than 130 databases comprising nearly 2.5 million independent vegetation plots have been registered in GIVD (Dengler et al. in press). 1.35 million of those coming from Central Europe (Jansen et al. in press). The web page counted 400000 visitors since its launch. We conclude that the vegetation-plot data whose accessibility is now much facilitated through GIVD constitute a huge and particularly valuable source for biodiversity research and macroecology, in particular as they combine small grain with huge spatial extent.

E4-P11: Biodiversity in Southern Africa - a three volume series on biodiversity research

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Recently, the three-volume series "Biodiversity in southern Africa" has been published. On nearly 1,500 pages, 200 researchers from various countries report on the results of one decade of joint research by South African, Namibian, and German institutions within the project "BIOTA Southern Africa".

The "backbone" of BIOTA Southern Africa is a globally unique transect through six biomes with 37 BIOTA Observatories of 1 km^2 each, on which biodiversity data of various taxa (lichens, biological soil crusts, vascular plants, millipedes, several taxa of insects) as well as the major drivers of biodiversity (weather, soil, land use) have been recorded according to standardised protocols. For the vegetation (vascular plants), the sampling was particularly elaborate with many replicates, different spatial scales, and annual repetition.

Volume 1 reports on the sampling methods and presents the biodiversity baseline data for all Observatories in a detailed and informative manner. Volume 2 analyses the data along the transect and in relation to climate and land use change. Finally, Volume 3 combines the results from the various disciplines into integrated views per biome, linking findings of the natural sciences to socioeconomic perspectives.

With its attractive full-colour layout, its magnificent photographs, and its moderate price, the series is not only attractive for scientists of the included disciplines (botany, zoology, ecology, soil science, agriculture, social sciences, etc.) but also practitioners (farmers, conservationists, politicians), and interested laypersons. Thanks to the uniqueness of the presented data from a subcontinent particularly susceptible to climate change and the innovative sampling approach, the series will also be valuable to researchers outside southern Africa.

The poster will give an overview of the content and structure of the 3-volume series.

E4-P12: Plant diversity of Hyrcanian forests, N Iran, toward a vegetation classification

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Hyrcanian vegetation zone is a green belt stretching from Talish in Republic of Azerbaijan and over the northern slopes of Alborz mountain in north of Iran. This area in Iran is approximately 800 km long and 110 km wide and has a total area of 1.85 million. This area is considered to have been a remarkable refugee for number of Tertiary relicts during the Quaternary period. Hyrcanian forests stretch out from sea level up to an altitude of 2800 and is a humid zone that average annual rainfall ranges between 530 to 2000. This research is an on-going investigation on plant diversity and vegetation of this relic forest and intercorrelation between altitude and species richness. Floristic data related to the species distribution, life form, altitude and habitats were extracted from the reviews, monographs and floras and our field experiments across different parts of this forest. A total of 3556 plant taxa were encountered belonging to 144 families. The highest species richness family is Asteraceae with 440 taxa. The flora is composed of endemic species which 334 taxa (9.4%) are endemic to Iran and 264 taxa (7.42%) are only found in the Hyrcanian area. Along with effect of Euro-Siberian florat on the area, Irano-Turanian flora are also remarkable in different part of the area especially in higher altitudes. The result of this investigation indicates that the species richness increased along the altitude from sea level until 1200-1300 m but decreased in higher altitude. The preliminary analysis on the vegetation of the area using all collected relevés indicate five main groups of relevés across the Hyrcanian area, i: a vegetation characterized by *Alnus glutinosa* subsp. *barbata*, *Populus caspica* and *Pterocarya fraxiniofolia* on wet lowland areas, ii: foothill and submountain forests characterized by *Parrotia persica*, *Carpinus betulus* and *Quercus castaneifolia*, iii: a relatively large and unique forest of *Fagus orientalis* in the mountainuous areas, iv: upper-mountain vegetation characterized with large stands of *Quercus macranthera*, v: shrubby-steppe ecotone area characterized by *Berberis* spp., *Crataegus* spp., *Carpinus orientalis* and *Paliurus spina-christii*.

E4-P13: Understory vegetation as indicators of soil characteristics in forests of N Iran

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The Hyrcanian forests are unique deciduous forests in arid or semiarid country, Iran. The ecological profile of these forests have been assessed along two altitudinal gradients using TWINSPAN and corrected frequency (CF) analyses. Altitude ranges between 300 and 2300 m a.s.l. For collecting species and environmental data, three plots were collected in each 100 m elevation in the forest and ecotone areas. Three soil samples were taken per plot. The parameters were the presence and absence of vegetation species and the soil variables grouped into three levels (low, mid and high) by the 33.3 and 66.7 percentiles. The matrix had 122 rows (plots) and 412 columns composed as follows: 379 vegetation species; eleven soil variables (N, P, K, $CaCO_3$, EC, pH, organic matter, C:N ratio and percentage of sand, clay and silt) forming 33 (11 × 3) levels. The ecological profiles method was used to evaluate the affinity and significance of the associations between probability of species occurrence and topsoil characteristics found by the polythetic method. Chi-square goodness-of-fit testing was used to investigate whether the observed distribution of a species along a given topsoil gradient showed significant departures from the distribution expected under the null hypothesis of uniformity. Five vegetation groups were classified, of which two occur in ecotone area and three groups occur in the forest parts. The indicators of each vegetation group with high fidelity were used for corrected frequency analysis. Therefore, 42 plant species were assessed of which 13 species had significant relationships with eight soil factors. Our results indicate that the selected species were indicator of certain soil variables in the Hyrcanian forests. Moreover, endemic plant species were restrictedly distributed on specific soil factors.

E5 Biodiversity effects on Ecosystem Functioning in Forests

Oral Presentations

E5-O1: Impact of species richness and topography on aboveground biomass in a forest

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As the problem of global warming has been increasingly worsening in the past decades, there is a growing need to advance our understanding of systems that absorb carbon from the atmosphere and store it in long-term pools. Spatial-explicit information of individual trees obtained from forest dynamics plots provides unique opportunities to explore the factors that determine aboveground biomass, a reasonable surrogate for carbon capture. The Fushan Forest Dynamics Plot, located in the Northern Taiwan, is one of the largest forest dynamics plots in Taiwan. In this study, we utilized the 2002 census data of the Fushan plot to examine fine-scale spatial variability in aboveground biomass and study how various abiotic and biotic factors may influence aboveground biomass. Relationships between aboveground biomass and three factors, including convexity, slope, and species richness, at the quadrate level were estimated via generalized square models (GLS). Our results show that the mean biomass was 284.7 mg/ha within the Fushan plot. There is considerable spatial variability within the plot. Such spatial variability can be explained by convexity and species richness, but not slope. Humped relationships were discovered between aboveground biomass and convexity/species richness, which suggested that aboveground biomass peaked at the intermediate level, but lower at the extreme values. The highest value of aboveground biomass occurred at the fat area where convexity was close to zero. The impact of convexity may be attributed to typhoon disturbance. Trees at the flat areas are usually larger since they are protected from typhoon. In the future, we will extend the analysis to other forest dynamics plots in Taiwan in order to discuss the factors that influence forest biomass from a board perspective.

E5-O2: Soil microbial communities in relation to subtropical forest characteristics

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Soil microorganisms, as regulators of many key nutrient cycles, play an important role in ecosystem function. Thus it is important to understand how microbial communities grow and function in relation to plant growth, plant biodiversity, and soil characteristics. The BEF China (Biodiversity and Ecosystem Functioning) project, based in subtropical China, is a large collaborative ecological study ideal for exploring these relationships. Initial samples were taken from three forest age classes in comparative study plots (CSPs), established to study forest reestablishment over time. Microbial biomass, community structure, and function were then determined using Substrate Induced Respiration (SIR) and Phospholipid Fatty Acid analysis (PLFA). Multivariate statistics were then used to compare the microbial communities with soil and plant community parameters that had been measured by project collaborators. Results suggested many interesting relationships. First, microbial activity (SIR) was more correlated with soil characteristics, while microbial community biomass and composition were more correlated with different parameters of forest productivity including herb layer cover, tree canopy cover, and biomass of woody recruits. Specifically, microbial biomass and individual lipid indicators were positively correlated with the biomass of woody recruits and with litter cover, while these indicators were negatively correlated with dead wood biomass. Based on these results, we will experimentally examine the effects of tree growth, forest diversity, and litter decomposition to more deeply determine how forest dynamics are related to microbial community biomass, structure, and function.

E5-O3: Changes in fungal community structures among forest successional stages

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Fungi are essential for maintaining the cycle of nutrients through ecosystems by decomposing organic material, making it available for plants and other organisms, and improving plant nutrition through mycorrhizal symbiosis. Knowledge on the diversity and species composition of fungal communities in a particular ecosystem is crucial to identify the key players and understand their role in ecosystem functioning. Within the framework of the forest Biodiversity and Ecosystem Functioning (BEF China) project, based in subtropical China, we investigated the soil fungal diversity and community structure in a subtropical forest ecosystem along three forest successional stages using high throughput molecular tools. Soil samples were collected from comparative study plots established within the Gutianshan National Nature Reserve. Metagenomic DNA was extracted from the different samples and the fungal ITS rDNA region was amplified using custom fungal specific primers for pyrosequencing of barcoded amplicons. High quality sequence reads were extracted and clustered into operational taxonomic units using cd-hit-454 script at a 97% sequence similarity level and taxonomic assignment of representative sequences were performed using blast and the NCBI nucleotide taxonomy.

Our results showed that the investigated subtropical forest ecosystem consists of a huge fungal diversity mainly composed of members of Basidiomycota followed by Ascomycota, whereby the fungal community composition differs significantly between the forest successional stages. Multivariate analysis of the fungal community structure in relation to plant and soil related parameters also indicated significant correlations between different fungal communities, plant communities and soil parameters. In the presentation, the role of different soil fungal communities in the functioning of the three forest successional stages of this particular subtropical forest ecosystem will be discussed.

E5-O4: Succession of *Cytisus scoparius* shrubberies in the Eifel National Park

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In 2004, the Eifel National Park was founded to protect and develop semi-natural woodrush beech forests. On several grassland areas, utilisation was ceased because they are located in the Park's core zone. Those areas are characterised by a mosaic structure of abandoned grassland zones and shrubbery stages that are dominated by common broom *Cytisus scoparius*. In consequence of the historico-cultural land use, these broom stands are landscape-characteristic elements in the Eifel region. To gain knowledge about the course of the broom shrubbery succession, the succession stages as well as important processes significantly influencing the course of succession were investigated in 2010. To this end, the observed shrubbery areas were classified into different age classes by comparing aerial photographs of different years. Vegetation and environmental factors were investigated at selected sites using space-for-time substitution. The establishment of broom and wooden pioneers was found to be influenced by a disturbance of the grass layer. *Cytisus scoparius* promoted the migration of *Rubus* species. The *Cytisus-Rubus* stands developed further to mixed shrubberies dominated by *Crataegus monogyna* and *Prunus spinosa.* Climax species like *Fagus sylvatica* could be found in those mixed shrubberies. Many of the young wooden individuals were damaged by browsing of wild game. Therefore, it can be assumed that natural reforestation will only appear depending on thorny nurse plants. The disturbance of the grass layer, the avichorous dispersal of *Rubus idaeus*, *Rubus* spec., *Crataegus monogyna*, *Prunus spinosa,* and climax species seeds as well as browsing defence are important factors that facilitate a forest establishment.

E5-O5: The abrupt decline of bilberry under beech in conifer dominated forests

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Bilberry (*Vaccinium myrtillus* L.) is a dwarf shrub with high ecological relevance as habitat and food source for animals. It is an important factor in habitat models and management plans for grouse species. An abrupt decline in once dense carpets of bilberry under lone beech trees has frequently been observed in conifer dominated forests and on gradients going from mature conifer into beech stands. As common and as obvious as this phenomenon is; it had not yet been studied.

Our objectives were: 1. to determine if the vitality of bilberry is negatively impacted by increasing the proportion of beech (*Fagus sylvatica* L.) in Norway spruce (*Picea abies* Karst.)

forests where the vitality of bilberry is measured by cover, height, biomass, shoot length and basal diameter and 2. to determine if these changes in bilberry vitality are related to light, canopy cover, soil pH, organic layer mass, tree species and site.

The data was collected on three sites in stands adjacent to each other consisting of pure spruce, pure beech, and if achievable in the ecotone.

On all three sites a clear increase in the vitality of bilberry (all characteristics) was observed on a beech-spruce gradient. Accordingly, mixed effect models show that spruce forest is the most important factor explaining the increase in bilberry biomass. Light had a small positive effect whereas soil properties had neglectable effects and were site specific.

These results gave a strong indication of the negative influence that beech has on bilberry in conifer dominated forests. This has to be taken into account when developing management plans in capercaillie habitats especially when considering recent trends where the proportion of beech in forests is being increased. Further research on a broader range of sites is needed to find out which factors and thresholds of tree species composition are behind this phenomenon. Among other factors leaf litter may be acting as a long-term mechanical barrier to bilberry's success.

E5-O6: Testing the enemies hypothesis for generalist predators in phytodiverse forests

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Ecological theory and experimental manipulations have revealed the potential of predators to significantly affect ecosystem functions. However, the relevance of these findings for species-rich, real-world ecosystems is difficult to evaluate, as we even lack general information on the relationships between predators and plant diversity in such ecosystems. The enemies hypothesis predicts higher abundance and species richness of predators and a concomitantly more effective herbivore control with increasing plant diversity, but this hypothesis has been derived from studies of relatively species-poor ecosystems. We studied patterns in species richness and activity abundance of an important group of generalist predators, epigeic spiders, in an extraordinarily phytodiverse forest ecosystem in subtropical China, across a gradient from medium to high tree species richness (25-69 species per plot). Contrary to expectations activity abundance and species richness of spiders decreased with increasing tree species richness, while rarefied spider richness and the temporal variability in richness and activity abundance were not related to plant diversity. Only foraging guild richness of spiders showed a positive correlation with tree species richness. Our results thus provide little support for an often assumed positive relationship between predators and plant diversity, as posited by the enemies hypothesis, and question whether better herbivore control can be expected in the more diverse plots of our highly diverse forest ecosystem. Our findings have implications for evaluating the way in which theoretical predictions and experimental findings of functional predator effects apply to species-rich forest ecosystems, in which trophic interactions might play an important role in the maintenance of high tree species richness.

E5-O7: Allometric identity effects in multi-predator food webs

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The global decline in biodiversity may have dramatic consequences for ecosystem functioning. The effects of higher level consumer diversity loss on ecosystem functioning are obscured by the complexity of natural food webs, including frequent intra-guild predation. One species may act as a predator on a focal prey and thus have a direct negative effect, or it may have an indirect positive effect by feeding on the focal species' predators. Here, direct and indirect effects mix up and may enhance, decrease or not affect ecosystem functioning, which renders the consequences of random species loss unpredictable.

We developed a novel concept of allometric identity effects integrating different species' traits that all depend on body mass. This allometric identity concept succeeds in predicting the outcome of a microcosm experiment with predators of the litter layer. Furthermore it can be applied to simulate the effects of predator diversity on ecosystem functioning dynamically. This approach integrates two phenomena of diversity experiments concerning scientists for the last two decades: sampling effects and niche complementarity.

The findings are relevant for litter food webs and the ecosystem function of decomposition. First, invertebrate predators of the litter layer in deciduous forests are predominantly generalists and their diet breadth is body size structured. Second, the lack of top-down control of detritivores indicates the presence of an effect-reducing mechanism within the predator community, which can be assigned to body-mass determined intra-guild predation. Our approach offers a new perspective on the interplay among complex interactions within strongly interwoven food webs, while being easily extendable to include body-mass independent parameters like species' phylogeny. We anticipate that allometric identity effects are an important tool for predicting the consequences of biodiversity declines across ecosystems.

E5-O8: 'Trophic whales' as biotic ecosytem buffers against external stressors

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Human activities may compromise biodiversity not only by direct species loss but also by effects inducing unstable dynamics. However, some ecosystems maintain relatively high complexity levels despite experiencing continuing disturbances suggesting that some intrinsic properties prevent unstable dynamics and resulting extinctions. In this vein, weak interactions have been suggested as stabilizing elements of complex systems but their relevance has rarely been tested experimentally. Here, we present a theoretical concept for an *a-priori* identification of species that stabilize externally induced instability based on network and allometric theory, which is rigorously tested in an experiment employing a soil food-web motif. Our results indicate that large basal-feeding species can buffer ecosystems against enrichment-induced unstable dynamics. Similar to the functionality of chemical or mechanical buffers, these species serve as 'biotic buffers' that take up stressor effects and preserve systems from instabilities. We refer to this class of species as 'trophic whales' as their representatives share important characteristics with the baleen whales: (1) a high individual body mass and thus a low per unit biomass feeding rate, (2) they consume basal resources, and (3) they are almost invulnerable to predation. In a microcosm experiment, we found that (i) enrichment increases biomasses in a three-species soil food chain causing a potential for feedback loops, and that (ii) addition of earthworms, as trophic whales, impedes this effect and additionally dampens population oscillations. We identify and discuss trophic whales as common entities in ecosystems. Considering increasing stressor effects under anthropogenic global change, the conservation of these network-intrinsic biotic buffers may help to maintain the stability and diversity of natural ecosystems.

E5-O9: Growth and competition of tree saplings of subtropical China

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One tenet of biodiversity and ecosystem functioning research is the dependence of ecosystem functions on species-specific differences in traits. As regards subtropical forests, however, there is a lack of studies that provide evidence for a (theoretically deducible) niche differentiation among tree species that are typical of these systems. In our study we thus analysed mechanisms that may promote the coexistence of tree saplings, taking four early-successional subtropical species as an example (*Schima superba*, *Elaeocarpus decipiens*, *Quercus serrata* var. *brevipetiolata* and *Castanea henryi*).

We conducted an experiment in which we tested for species-specific differences in growth variables, by manipulating species composition (monocultures, two-species and four-species mixtures), stand density (low, intermediate, high) and species richness (one, two, four species). Three groups of response variables describing sapling growth (height and diameter), biomass allocation (in relation to different strata and constituents) and sapling architecture (including branch demography) were analysed by mixed effects models.

This is the first study that describes different strategies in branch demography in a community of woody plants. Effects of species identity and species composition on growth rates and performance of tree saplings point to niche separation as a mechanism of species coexistence, whereas species richness proved to be of minor importance.

E5-O10: Testing for N-use complementarity among four tree species using ^{15}N tracers

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The use of ^{15}N tracers in biodiversity - ecosystem functioning (BEF) research has been proven to be an effective tool to study N-use complementarity and to characterize niche space. In principle, coexisting plant species competing for the often limited resource nitrogen can reduce interspecific competition in three distinct ways: spatial, temporal and chemical N-use partitioning. Overyielding effects in biodiversity experiments, i.e. where mixtures are more productive than the corresponding monocultures, have often been attributed to belowground niche partitioning leading to a higher exploitation of nitrogen resources. We studied nitrogen resource partitioning among four subtropical tree species growing in monoculture and mixture by injection of ^{15}N tracers ($^{15}NH_4Cl$, $K^{15}NO_3$, dual-labelled glycine) at two soil depths (5cm and 20cm) in four seasons. Six days after tracer application tree saplings were harvested and $\delta^{15}N$ was measured in roots, stems and leaves by IRMS. Tracer application led to a high enrichment of plant $\delta^{15}N$. Excess ^{15}N was higher for evergreen than for deciduous species with evergreens maintaining high N uptake into roots even in winter. Species-specific N acquisition patterns from different soil depths were rather similar with all species relying on about 85% of N taken up from the shallow soil layer. Evergreen species preferred nitrate whereas deciduous species relied more on ammonium with consistent pattern in monoculture and in mixture. Our results show that coexisting subtropical tree species can reduce to some extent interspecific competition by exploration of different N sources and differences in seasonal N uptake dynamics. However, enhanced community performance in mixture, i.e. greater total community utilization of resources, still has to be proven to assess N-use complementarity.

E5-O11: More plant lineages in the litter - less mineralization

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Plant communities differ drastically in their phylogenetic diversity. What are the consequences for ecosystem functioning and more specifically for the decomposition of litter? Does an increased diversity of lineages result in increasingly complementary resources for litter-feeding decomposers, in more diverse decomposer communities, and in a more efficient decomposition? Or does increased diversity of lineages result in reduction of preferred resources for any group of decomposers, with a decrease in their efficiency, and in decomposition? We experimentally tested how decomposition depends on phylogenetic diversity of litter (ranging from within 12 tree species to two-species combinations within and between 4 genera and 4 families). We found no effect of increased phylogenetic diversity on litter-mass loss or diversity of multiple invertebrate decomposer taxa. However, we found a decrease in the microbial mass and slower improvements in C/N ratios. High phylogenetic diversity of plants seemed hence to impede the processing of their litter by decomposers. We stress that our (and most other) experiment does not account for possible local trait evolution in response to coexisting plants. We suggest that the increased mineralization of litter composed of closely related plants favours their coexistence and thereby the evolutionary conservatism of niches.

E5-O12: Biodiversity-effects on resistance to foliar fungal pathogens

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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 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 is positively and 2) pathogen load per individual is negatively related to the number of host tree species, and 3) tree diversity reduces the risk and pathogen load by transmission reduction. Pathogen diversity and load was determined on two deciduous and two conifer tree species (*Quercus petraea, Fagus sylvatica, Picea abies, Pseudotsuga menziesii*) of the eight year old BIOTREE-tree-diversity-experiment in Kaltenborn, Thuringia, Germany. Micro- and macroscopic assessment of pathogen load was performed by a complete qualitative and quantitative survey of all fungal pathogens present for a representative sample set of leaves or needles of each tree individual. Results showed that tree diversity had no strong effects on pathogen species and pathogen load. In contrast, we encountered strong tree species identity effects with *Quercus petreae* and *Picea abies* contributing disproportionally to high and low plot pathogen load, respectively. In consequence, plant species composition of communities should be taking into account with respect to pathogen infection, while species richness effects might not yet be apparent in such comparatively young experiments.

E5-O13: Establishment success of the forest plantation experiment on BEF-CHINA

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Experimental forest plantations in biodiversity–ecosystem functioning research in subtropical regions are rare and often suffer from many practical problems such as unsatisfactory establishment. In the context of a joint Sino-German-Swiss Research Unit BEF-China, 271 experimental forest plots of 400 trees each, ranging in diversity form monocultures to 24-species mixtures have been planted in 2009 in Jiangxi Province, with additional replanting in 2010. A pool of 24 native tree species and 2 conifers used in commercial plantations were used to form experimental communities. Here we present the practical procedure and report on the establishment success based on survival inventories carried out in November 2009 and June 2010. Both evergreen and deciduous species established survived the transplanting very well with an overall survival rate was 87% during the first 14 months. Analysis with generalized mixed-effects models showed that survival rates of seedlings were significantly affected by species richness, topographical variables and species identity. The variation in survival rates among species was partly explained by better survival of deciduous compared with evergreen species (0.93 > 0.83). Plots with 8-species mixtures had the highest survival rate (0.93 ± 0.015) compared to plots with 4-species mixtures with the lowest survival rate (0.80 ± 0.036). Altitude and curvature were positively related to survival, while increasing slope had negative effects. These results have important implications for establishing BEF experiments with trees but also for applied afforestation projects.

Poster Presentations

E5-P1: Fine root morphology and distribution in a mixed-species forest

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Positive biodiversity effects on productivity are mainly attributed to the complementary use of above and belowground resources of different species in species-diverse plant communities. Compared to aboveground canopy stratification, little is known about belowground niche complementarity in species mixtures. Here we assessed the effect of tree species richness on belowground fine root morphology and vertical distribution patterns in a 6 year old field diversity experiment. This study was part of the BIOTREE experiment, where four tree species seedlings, *Picea abies*, *Fagus sylvatica*, *Quercus petraea* and *Pseudotsuga menziesii* were planted following a simplex design in 2003 and 2004 in Thuringia, Germany. Fine root samples were collected with soil cores and the ingrowth core method (0-30 cm soil depth) from a replacement series of four sapling combinations ranging from 1, 2, 3, and 4 tree species within a well replicated and fully balanced design. Overall fine-root length density did not differ significantly among the different tree species diversity levels. But the fine-root growth performance and distribution of different species responded to the presence of the other tree species differently. In mixed stands *P. menziesii* and *P. abies* had higher fine root growth rates

than in monocultures, whereas the reverse was true for *F. sylvatica* and *Q. petraea*. Moreover, the fact that *P. abies and F.sylvatica* allocated more fine roots to the upper soil layer, whereas *P. menziesii and Q. petraea* produced more fine-roots in the deeper layer indicated the potential for vertical fine-root niche segregation. Meanwhile, the different fine-root morphological plasticity of different species in response to the tree species diversity may imply different soil exploitation strategies of different tree species in this mixture.

E5-P2: Soil water uptake in single and mixed species tree groups of a temperate forest

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The objectives of this study were to (1) identify possible effects of tree species identity and mixture on soil the water balance and (2) vertical distribution of water uptake by trees in a temperate deciduous forest. For this purpose 16 tree clusters were selected in the Hainich forest, Germany, each consisting of three co-dominant trees and their surrounding neighbours. Observed species were beech (*Fagus sylvatica*), ash (*Fraxinus excelsior*) and lime (*Tilia cordata*) combined in single- and three-species groups (n=4). Volumetric soil water content was measured with FDR sensors (at 0.1 - 0.7 m soil depth) in 0.1 m intervals and throughfall with four collectors per cluster. A soil water budgeting was conducted to estimate the daily soil water uptake of the trees during a desiccation period in 2009. Additionally, a stable isotope analysis was carried out to assess the natural abundance of ^{2}H (deuterium) and investigate on the soil water uptake depth of the different species. Hence, soil samples were taken from the soil profile in 0-0.1, 0.1-0.2, 0.2-0.3, 0.3-0.5 and 0.5-0.7 m depth in addition with stem samples from the cluster trees.

The water budgeting didn't reveal any significant effect of tree species identity nor species mixture on the daily amount of soil water uptake during the desiccation period. Soil water isotopic signatures of δ^2H (ranging between -30 and -80 δ‰) declined with depth in the soil profile from the topsoil to 0.5 m levelling off at 0.5 to 0.7 meters. Direct inference comparison of tree and soil isotopic signatures showed similar depth of soil water uptake for all observed species and the mixture at 0.3-0.5 and 0.5-0.7 meters. A linear isotope mixing model showed that the fraction to which the trees utilized these soil depth differed between the single and mixed clusters. This hints to a diversity effect with regard to complementarity between the species.

E5-P3: Leaf litter diversity and stoichiometry effects on macrofaunal litter processing

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The primary decomposers on forest floors play an important role as habitat transformers via resource fragmentation. They contribute to the ecosystem function of nutrient cycling by litter processing. Furthermore recent studies revealed the importance of the macrofaunal invertebrates for the different decomposition rates of leaf litter species. Influenced by the metabolic theory of ecology (MTE) and the theory of ecological stoichiometry (ES) we want to investigate the drivers of the macrofauna-leaf litter interaction: How does leaf litter diversity drive the maximum consumption rates of the macrofauna? Is there a bodymass dependency or is the resource quality a better explanatory variable of the interaction? To open the black-box we use a laboratory experiment with ten decomposer species feeding on ten leaf litter species of temperate forests. In addition to that we want to quantify the consumption rates analogue to a predator-prey functional response assuming a non-linear interaction. First results and an outlook for predicting decomposition rates by food web modelling will be shown.

E5-P4: Dead wood colonization by xylobiontic beetles in differently managed forests

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Dead wood as an essential part of the forest ecosystem and important resource for specialized arthropods has received increasing attention during the last years. Our study was carried out in 30 forest plots of the Biodiversity Exploratories: Schorfheide-Chorin, Hainich-Dün and Schwäbische Alb in Germany. The forest plots were divided into unmanaged and managed forests. Managed forests were further subdivided into age-class and selection forest. In the different forest types we investigated the colonization patterns of xylobiontic beetles in experimentally exposed fresh dead wood stems of 13 tree species. Our main questions were: How does the diversity of xylobiontic beetles change during dead wood decay and how specialized are these beetles? Is the diversity of xylobiontic beetles higher in unmanaged forests than in managed forests? We used closed emergence traps, which were installed on the lying stems to sample all beetles hatching from the stem. The traps were emptied in an interval of four weeks from April to October 2010 and 2011. On each plot two replicates of the 13 tree species were exposed, so overall we had 780 stems with emergence traps. After one year, the traps were shifted alongside the stem to provide evidence of the colonization pattern of xylobiontic beetles.

E6 Biodiversity and ecosystem functions in open landscapes

Oral Presentations

E6-O1: Halting the loss of biodiversity: Europe's endemic rich open landscapes

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Due to their limited range endemic species are said to be more in danger of extinction than widespread species. To hold the loss of biodiversity it is emphasised that the countries have a particular responsibility to protect all species that are restricted their territories. Our study focuses on endemic vascular plants in Europe. We ask which habitats are rich in endemic plants and should therefore be given conservation priority? We evaluated European floras in order to assign endemic taxa to predefined habitat categories e.g. rock and scree habitats, forest, grasslands, and other habitats. The endemism of Europe´s grasslands is to be highlighted: In terms of endemic richness, grasslands outmatch e.g. Europe´s forest ecosystems by far, although these open landscapes cover less than 10% of Europe´s land surface. At least 1,336 endemic plants inhabit grasslands and of these 351 taxa are absolutely restricted to this habitat category. It should, therefore, be evident that the conservation of European grasslands is of vital interest for in situ conservation (CBD, Article 8). However, the reason why grassland endemics are overlooked in the Red Books is that these species are often found in more than one country (only 336 national endemics). The fact that grassland endemics are spread over more than one European country should not be confounded with the assumption that these plants are widely distributed or have large population sizes. Land-use changes, fragmentation, or fertilization have resulted in a severe reduction in the quantity and quality of the once wide grassland landscapes of Europe. This process was already confirmed by the first assessment of habitats listed in Annex I of the Habitats Directive that stated a poor conservation status of grasslands. We therefore strongly support the efforts of the Smolenice Declaration that calls for a strategic framework for the protection of Europe´s unique grassland landscapes.

E6-O2: Invertebrate diversity patterns induced by extensive grazing in salt marshes

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Livestock grazing with intermediate stocking densities is a widely applied method to conserve and restore grassland ecosystems across Europe. In salt marshes, however, the long-term effects of intermediate stocking densities on arthropod diversity and its interaction with plant diversity are largely unknown.

At three German salt marshes we compared invertebrate and plant species richness under three different management regimes: commercial stocking density, intermediate density and abandonment. The sites with a commercial stocking density had a uniform short sward and the abandoned sites had a uniform tall sward. The sites with an intermediate stocking rate were characterized by a mosaic of tall vegetation (patches) and short vegetation (grazing lawns), which were sampled separately.

Within the intermediately grazed sites, we found a higher species richness for all invertebrate groups in patches of tall vegetation than in the grazing lawns, but no difference in plant species richness. A comparison between the three management regimes yielded less clear results, but most arthropod groups showed an increase in species richness with extensification of management. The opposite pattern was recognisable for the vegetation, which showed a higher species richness in the commercially grazed sites than in the abandoned sites. Both, however, showed no significant difference with the intermediately grazed sites. No conclusive relationship was found between plant species richness and any of the invertebrate groups.

We conclude that the formation of a vegetation mosaic under intermediate stocking rates will create a higher arthropod species richness than under commercial densities. Abandonment, however, does not necessarily have a detrimental influence on diversity, but will change the species composition.

E6-O3: Grazing drives biodiversity and ecosystem function in coastal grasslands

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Coastal sand dune grasslands are bio diverse habitats that provide ecosystem services such as soil formation, nutrient cycling, carbon storage, water storage, coastal flood prevention and recreation. It is well known that intermediate livestock or pony grazing of sand dunes promotes plant diversity. However, it is less well known how grazing management influences the biodiversity of other groups, both above and below ground, and ecosystem function in the context of ecosystem services. The impact of grazing on biodiversity and ecosystem service provision of a temperate sand dune system was assessed using three levels of grazing intensity; pony and rabbit grazed, rabbit grazed and un-grazed. Biodiversity is linked to cultural services through habitat aesthetics and recreational use, but also drives ecosystem processes; we measured plant and invertebrate abundance, species richness and functional group structure, also total microbial, bacterial and fungal PLFA diversity. Primary productivity and nutrient cycling are both key ecosystem supporting services. The following parameters linked to nutrient cycling were measured; soil temperature and moisture, availability of nitrogen from animal dung and plant detritus for plant and microbial growth, underground detritivore feeding activity and root turnover. Regulating ecosystem services include carbon storage for equable climate and aquifer water storage. Carbon stock was calculated using above ground plant, litter

and root biomass and soil carbon content. Water infiltration rates were also measured. Here we discuss the implications of grazing management for biodiversity, ecosystem function and ecosystem service provision in a model grassland system. Preliminary results suggest that pony and rabbit grazed coastal grasslands show greater plant and invertebrate diversity than rabbit grazed or un-grazed treatments. Ecosystem services such as nutrient cycling and carbon storage show a more complicated relationship with grazing intensity.

E6-O4: Stress as a key factor for the Niobe Fritillary (*Argynnis niobe*) in heavy-metal grasslands

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The Niobe Fritillary (*Argynnis niobe*) showed a dramatic decline throughout Central Europe in the past decades. We studied the larval habitat preferences of the last (meta-)population of *A. niobe* in North-Rhine Westphalia near Aachen. Heavy metal grasslands (*Violetum calaminariae*) with the regional endemic host plant *Viola calaminaria* form the habitat of *Argynnis niobe*. The combination of host plant abundance and vegetation structure explained the occurrence of *A. niobe* larvae best. Sparse vegetation with a high density of host plants was preferred. Plant physiological stress, a specific site characteristic of heavy metal grasslands, seemed to afford the persistence of suitable larval habitats. High heavy metal contents in the soil (mainly zinc in the study area) reduce the speed of succession and keep the vegetation sparse. Hence, stress must be seen as a key factor for *A. niobe* in heavy metal grasslands while disturbance plays the major role in other habitats as coastal dunes or semi-natural grasslands. *Argynnis niobe* is known as a species which requires large areas of well connected habitats. High densities of the host plant *V. calaminaria* are possibly the reason why *A. niobe* survived in a region with a fairly small area of suitable larval habitats. The life cycle of *Argynnis niobe* in heavy-metal grasslands differed significantly from that of the coastal dunes as the larvae emerged several weeks later. Possible explanations (e.g. macroclimate, microclimate, synchronisation with the host plant life-cycle) are currently being tested and will be discussed.

E6-O5: The diversity-productivity relationship in differently managed natural grassland

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Agricultural intensification has transformed most grasslands of Central and Western Europe from extensive to highly intensive management during the last 50 years, resulting in large reductions of plant species diversity. This impoverishment has raised concern whether ecosystem functions such as productivity have been affected as well. A positive effect of diversity on productivity was found in experiments with synthetic grassland systems but was rarely confirmed in semi-natural grasslands in the field.

We conducted a three-factorial experiment (fertilization, mowing frequency, diversity; n = 6) in a permanent grassland to disentangle the effects of management intensity and diversity on aboveground biomass and biomass production, fine root biomass and root distribution patterns. Selective herbicides were applied to increase the diversity gradient across the plots.

While fertilization had a strong positive effect on aboveground biomass and biomass production and the cutting frequency a minor one, the effect of plant species richness on aboveground standing biomass was insignificant and the aboveground biomass production was negatively related to species richness. The fine root biomass and its distribution patterns gave no indication of belowground complementary resource use to be a relevant force for potential overyielding in species rich plots.

We conclude that the nitrogen-driven productivity increase is by far more influential on aboveground productivity than any possible diversity effect, which was not detectable in this permanent grassland. Additional field manipulation studies in mature communities are needed to fully understand the mutual productivity-diversity relationship in grasslands under changing land use.

E6-O6: Response of grasslands varying in land use intensity and diversity to drought

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For future conservation strategies it is fundamental to understand the consequences of species extinctions for ecosystems and their functioning. A lot of field experiments especially in grasslands have been established to study the role of plant diversity on ecosystem processes such as productivity or element cycling, or the stability of these processes against perturbations, such as climatic extremes or land use changes. The effect of biodiversity on the stability of plant communities against future climatic changes, such as prolonged summer drought, is still marginally understood. A negative relationship between species richness and resistance against drought and a positive relationship between species richness and recovery has already been found. But it has never been tested before, whether those findings hold under different land use intensities. Land use has an important impact on species richness and composition and thus may influence the stability of grasslands facing drought.

Our experimental setup manipulated summer drought (roofed vs. unroofed sites), plant species loss (6 levels of 60 down to 1 species) and land-use intensification (4 levels varying in mowing frequency and amount of fertilizer application) in combination. Stability was measured as resistance and recovery of aboveground biomass production in grasslands against decreased summer precipitation. We found that stability properties of grasslands against summer drought are highly dependent on land-use intensity. Frequently mowing reduced the resistance of grasslands against drought especially in species-rich communities, whereas species-rich communities showed a higher ability to recover from the perturbation only in the most intensive land use type. Species abundance shifts may explain our findings.

E6-O7: Plant diversity effects on arthropod communities in an experimental grassland

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Plant diversity changes can have serious impacts on abundance, diversity, and ecosystem functioning of species at higher trophic levels. We used an experimental gradient of grassland plant diversity ranging from one to 60 plant species to study arthropod communities, and analysed their diversity (species richness), and abundance in 2010. Ground associated arthropods were collected by using pitfall traps which were emptied biweekly over the whole vegetation period (April- September). With our sampling we repeated measures from 2003 and 2005 to analyse how patterns develop over the long term.

We asked the following questions: (1) How does plant diversity affect species diversity and composition of the invertebrate communities, and do these patterns change over the years? (2) How do the effects of changing plant diversity differ between the several groups (herbivores, predators, parasitoids), and are the effects of plant species loss comparably at the different trophic levels?

E6-O8: Effects of landscape and land-use on the diversity of trap-nesting hymenoptera

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How are regional landscape complexity and local land-use intensity related to the functional diversity of trap-nesting bees, wasps and their natural enemies?

Solitary bees have an important function as pollinators for plants and crops. However, the influence of (1) regional landscape complexity, (2) local land-use intensity (gradients of mowing, fertilization and grazing) and (3) experimental management treatments (mowing, succession, control) on bee communities and their natural enemies remains unresolved. Yet, the prediction of ecosystem services provided by solitary bees and wasps requires detailed knowledge of these three drivers. We investigated their influence across different spatial scales on functional diversity at different trophic levels, using trap-nesting bees, wasps and their natural enemies as model system.

In spring 2008, 760 trap nests (8 trap nests per plot) were installed on a total of 95 grassland plots located in the DFG Biodiversity Exploratories Hainich-Dün, Schorfheide-Chorin and

Schwäbische Alb. The experimental grassland plots differed in their land-use intensity and had been experimentally managed. After collecting the traps at the end of September, they were analysed for trap-nesting bees, wasps and their parasitism. Altogether 4560 nests were detected in the trap nests. After a diapause, emerging imagoes were pinned and identified. We found that community structure of trap nesting bees, wasps and their antagonists differed between the three exploratories. At a local scale, land-use intensity as well as experimental management treatments affect species diversity and the trophic interactions between hosts and natural enemies.

E6-O9: Landscape complexity and local management affect flower-visiting bees

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Pollination is an important ecosystem service ensuring cross-pollination in wild plant populations and major crops. Bees are the most important pollinators in agricultural landscapes and local management and landscape complexity has been shown to affect bee diversity and abundance. However, how local and landscape effects interact and how they vary across different regions remains unclear.

This study is part of the DFG research project 'Biodiversity Exploratories', which focuses on the relationship between land-use intensity, biodiversity change and ecosystem functioning in three regions. The project provides an extraordinarily large matrix of differently managed experimental plots and thereby, enables a large-scale approach to assess the relative importance of landscape and local management for the diversity and abundance of flower-visiting bees. The landscapes were mapped in a radius of 2km around each plot considering different land use types such as, for example, forest, woodland and semi natural habitat. We monitored flower visiting bees on 95 grassland plots in the three research regions. Overall, we recorded 1256 individuals of 51 species. Our results indicate that both landscape complexity and local management affect the species richness and abundance of flower visiting bees across the three regions.

E6-O10: Hemiparasitic plants affect community structure and biogeochemical cycling

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Hemiparasitic plants are considered keystone species and can change plant community structure through both direct parasitic effects on hosts and indirect litter effects on nutrient availability. We hypothesized that (1) the direct parasitic effect on aboveground biomass production is more important when productivity is higher and (2) the indirect effect of hemiparasitic plant litter on nitrogen (N) availability, in contrast, is more important at lower-productive sites. We tested these hypotheses (1) using a three year long hemiparasite removal experiment, (2) by quantifying hemiparasitic plant litter production and litter decomposition and (3) by following the N fate during decomposition of 15-N enriched hemiparasitic litter. All these experiments were performed in two semi-natural grassland types with contrasting nutrient status, i.e. mesotrophic grasslands parasitized by *Rhinanthus angustifolius* and oligotrophic heath-grasslands parasitized by *Pedicularis sylvatica*. We found that hemiparasite removal significantly increased standing biomass at *Rhinanthus* sites (not significant in *Pedicularis* sites); this was mainly due to an increase in graminoids. Furthermore, the amount (biomass and N content) of hemiparasite litter produced by *Rhinanthus* was only half of that produced by *Pedicularis;* this litter comprised 9 and 30% of the N removed by mowing for *Rhinanthus* and *Pedicularis* sites respectively. Within two months, about half of this hemiparasitic litter N was released during decomposition. Finally, the uptake of N released from decomposing 15-N enriched hemiparasitic litter varied greatly between species and seemed to be related to leaf phenology. We conclude that our hypotheses prove correct for these two semi-natural grassland types with contrasting productivity. These findings further improve our understanding of the functional role of hemiparasites.

E6-O11: Quantifying habitat-specific contributions to insect diversity in agroecosystems

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Agricultural intensification often leads to a loss and fragmentation of semi-natural habitats. As a consequence, biodiversity in modern agroecosystems declines. In order to minimize these negative ecological effects of changes in landscape structure, quantification of the contributions of different types of semi-natural habitat to agrobiodiversity and the associated functions is urgently needed for informed decisions in landscape planning and nature conservation. Surveying ecotone species richness of wild bees, true bugs and carabid beetles, we found semi-natural habitats in two differently structured agricultural landscapes in Switzerland to differ up to fourfold in their habitat specificity. Using statistical null models for both, habitat specificity and multiplicative beta diversity, we were able to determine habitat types that contributed more or less than expected to the landscapes' species diversity or departed from the expected variation in community structure among elements of the same habitat type. We found that differences in habitat specificity were smaller and the separation of habitat-specific communities clearer in the landscape characterized by a patchy, isolated distribution of habitat elements than in the more connected landscape situation. Whereas habitat types significantly differed in community composition for the combined as well as the taxon-specific data in the patchy landscape situation, habitat types were not clearly distinct in their communities of bees and true bugs in the more connected landscape. Taking also into account the number of red list species that move between the different semi-natural habitats and the agriculturally managed area, our results will help to understand better the habitat-

specific contributions to insect diversity in agricultural areas, thereby facilitating targeted conservation measures and sustainable landscape planning.

E6-O12: Woody elements in agricultural landscapes increase pollination of cherry trees

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Habitat loss and fragmentation are major threats to biodiversity and ecosystem functioning. Effects of these usually correlated processes on ecosystem functioning have rarely been separated at a landscape scale. We studied the independent effects of amount of woody habitat in the landscape and the local isolation from the next woody habitat on pollination of newly established cherry tree lines (*Prunus avium*). Woody habitats in agricultural landscapes provide nectar, pollen and nesting sites for pollinators, especially wild bees. We hypothesized flower visitation rates and fruit set to be higher in landscapes with high amount of woody habitat and lower at sites isolated from woody habitat. In spring 2011 flower visitors were observed with videotaping and fruit set was calculated as the proportion of cherry flowers that developed into initial fruits. Additionally, we performed a classical pollination experiment to estimate the importance of insect pollination for fruit set.

In the pollination experiment, cherry flowers covered with bags showed almost no fruit set, unless they were artificially cross-pollinated with pollen from other wild cherry trees. Open flowers showed an intermediate fruit set that strongly varied between sites. Together, this demonstrates obligatory insect pollination that is limited in some sites. In line with our hypothesis young cherry trees showed higher fruit set at sites connected to small scale woody habitats (such as hedgerows, single trees, tree lines or orchards) compared to sites isolated from any woody structures by 100-200 m. On the landscape scale, however, the amount of woody habitat did not influence fruit set. Preliminary results from the observations of flower visiting insects showed a similar pattern. Our results reveal the negative impact of local isolation from woody habitat for fruit set of young cherry trees, independent of the amount of woody habitat on the landscape scale.

Poster Presentations

E6-P1: Vegetation dynamics in pasture-woodland landscapes under climate change

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In most developed countries, the industrialization of agriculture has generally resulted in landscape changes from small-grained heterogeneous patterns towards more monotonous and mono-functional landscapes. Particularly the multi-functional pasture-woodlands of western Europe are threatened by a strong tendency towards segregation of land use, which leads to the spatial and functional isolation of large patches of intensively used grasslands (including the replacement of pastures by hayfields) from quasi-unmanaged forests. On the other hand, silvopastoral systems are among the most promising approaches for sustainable management of mountain areas world-wide. In the Swiss Jura Mountains, wooded pastures represent a traditional form of semi-natural landscape that is dependent on multiple and extensive land uses. Such systems have been shown to be very vulnerable to land use and climate change due to the complex interactions driving the dynamics of the grassland-forest-mosaic.

We use a spatially explicit compartment model of wooded pastures (WoodPaM) to simulate alternative scenarios of land use and climate change. The modelled successional dynamics in grassland and forest are plausibility-checked in simplified artificial landscapes. The model is calibrated on a time series of aerial photographs covering 80 years. Realistic scenarios of land use and climate change are simulated in two wooded pastures situated in the Parc Jurassien Vaudois, which differ in agro-economical constraints: A mountainous summering pasture (Amburnex) with subsidies paid per ABU is compared to a pasture integrated into “normal” agricultural landscape with subsidies paid per unit area (La Bullatonne).

The results show changes in cover and species composition of forests as a consequence of climate warming and summer droughts. This indicates the necessity of climate adaptive management in order to maintain the rich biodiversity of semi-open landscapes.

E6-P2: Seed bank diversity in the agricultural landscape of Eastern Transylvania

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Eastern Transylvania is well known for its plant species diversity of traditionally managed grasslands. In Harghita County, the Pagan Snow Cap Association, which was established in 1999, has been collaborating with farmers, NGOs and scientists to support traditional agriculture and to conserve the region’s biodiversity. So far, the main focus has been on the above-ground diversity of hay meadows and only little data is available on the diversity of recent and former arable land and soil seed banks in general. In cooperation with the Pagan Snow Cap Association, we thus sampled seed banks (n=18) from three habitats (recent arable land, former arable land converted to grassland and old grassland) in three parts of Harghita County (in the centre and on the eastern fringe of the Csík Basin and in the adjacent Gyimes Mountains. We took the soil samples (soil depth: 0-5, 5-10 and 10-15 cm) in March 2011, carried the soil to a common garden of Giessen University (Germany) and have applied the seedling emergence method under field conditions and with regularly watering. Additionally, we conducted soil chemical analyses and documented the land-use history of each sampled field. In the poster, we will present the first results of our ongoing study.

E7 Impacts of Environmental Change on Biodiversity: scaling up from Individuals to Communities and Landscapes

Oral Presentations

E7-O1: Plant populations in a changing climate - adaptation or plastic response?

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Climate change scenarios predict a considerable rise in global temperatures. How different plant species might respond to this (e.g. migration, phenotypic or genetic adaptation) is not clear. In mountain habitats peripheral populations at higher altitude will encounter climatic conditions similar to core populations at lower altitudes. However, they might be pre-adapted to some different local conditions (e.g. soil formation). We determined adaptation and phenotypic plasticity in response to changing environmental conditions in populations from core (1200m a.s.l.) and peripheral (1800m a.s.l.) altitudinal origin of three common grassland species (*Ranunculus bulbosus*, *Trifolium montanum* and *Briza media*). We tested the hypotheses that plants are adapted to their altitude of origin and that peripheral populations have higher phenotypic plasticity than core populations as a consequence of population isolation and habitat heterogeneity. Using climate chamber and transplant experiments (gardens at 600m, 1200m and 1800m a.s.l) we studied variation in plant responses to temperature, season length and soil conditions. In the climate chambers, plant growth increased with higher temperatures. Plant growth and fitness was greater in plants originating from 1200 m compared to 1800 m a.s.l. for all species in all temperature treatments. First analyses of the transplant experiment indicate differences in the relative growth rate and fitness of *R. bulbosus* originating from 1200 m and 1800 m a.s.l.. Growth and fitness decreased with the altitude of the experimental gardens irrespective of altitude of origin. *R. bulbosus* grew better in deep pure as compared to shallow stony soil conditions. Our initial interpretation of these findings is that our study species are not adapted to their altitude of origin. Variable growth in relation to environmental conditions indicates high phenotypic plasticity which might buffer plant species in a warmer world.

E7-O2: Adaptability of rare edge populations to climate change

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The mires of Northern Germany are inhabited by several rare plant populations, which grow there at the southern margin of their species' ranges. During the pleistocenic glaciations, these cryophilous species were possibly widespread in Central Europe followed by range contractions to higher latitudes and altitudes during periods of global warming. Today, the few remaining populations in Northern Germany persist in isolated habitat fragments. According to the 'Rear-edge-hypothesis', these populations experienced a comparatively long selection for tolerances of heat and drought stress, which could have resulted in specific local adaptations lacking in the northern populations. Therefore, the role of these habitats for the past and future evolution of bog plant communities could be crucial as a possible shelter for well adapted populations to future climate changes.

To test for differences in adaptive traits between core and edge populations, we planted populations of several bog plant species collected along a gradient from Northern Sweden to Northern Germany in a common garden into microcosms that 1) differed in species diversity and 2) were subject to different environmental conditions mimicking future climate projections (drought periods, enhanced temperature, enhanced nutrient supply). The expected data will allow predictions on prospective responses of wetland plant communities to climate change. These data may be important for the conservation of the few mires left in Central Europe and for other populations that occur at the margin of their species' ranges especially if the southern populations perform better in a drier and warmer climate compared to their northern conspecifics. In the first season, the dominant matrix species, *Sphagnum magellanicum*, grew better in mixtures than monocultures. This effect was especially pronounced in the most northern populations that therefore benefitted most from species diversity.

E7-O3: Specific responses to drought in genotypes of important European grass species

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Climatic extremes are expected to increase in magnitude and frequency. Especially, perennial plant communities of spatial and economic importance have to adapt to these changes. In Central Europe managed grasslands cover a large surface and contribute substantially to agricultural production. Here, we investigate four key grass species (*Arrhenatherum elatius*, *Alopecurus pratensis*, *Holcus lanatus* and *Festuca pratensis*).

Climatic envelopes are based on average climatic conditions and do not consider extremes. In order to evaluate future performance of grassland ecosystems, it is crucial to understand thresholds for population survival of key species. Furthermore, the climate envelope approach ignores the genetic variability within species.

We selected defined provenances of our target species across their European distribution and exposed these plants experimentally to extreme weather conditions (drought and heavy rain) in combination with and without warming.

Our results show that there is a species specific response to climatic extremes. In addition, the variability of response differs between species indicating species-specific differences in phenotypic plasticity. Provenance effects confirm that southern and continental provenances cope better with drought.

We conclude that in order to maintain ecosystem functioning and stability in European grasslands the search for populations and provenances that are best adapted to the expected extremes is a very promising approach. The assisted migration and integration of genotypes within species, however, may mix local gene pools. Seeing important ecosystems at risk in face of climatic extremes, this disadvantage may be accepted if regime shifts and ecosystem breakdown can be avoided.

E7-O4: Stochastic trajectories of succession initiated by extreme climatic events

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Deterministic or rule-based succession is expected under homogeneous biotic and abiotic starting conditions. Effects of extreme climatic events such as drought, however, may alter these assembly rules by adding stochastic elements.

We monitored the succession of species composition of 30 twin grassland communities with identical biotic and abiotic starting conditions in an initially sown diversity gradient between one and 16 species over 13 years. The stochasticity of succession, measured as the synchrony in the development of the species compositions of the twin plots, was strongly altered by the extreme warm and dry summer 2003. Moreover, it was independent from past and present plant diversity and neighbourhood species compositions.

Extreme climatic events can induce stochastic effects in community development and therefore impair predictability even under homogeneous abiotic conditions. Stochastic events may result in lasting shifts of community composition, as well as adverse and unforeseeable effects on the stability of ecological services.

E7-O5: Community stability - effects of complexity and interaction structure

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The response of whole communities to environmental changes and human activities, in particular community stability, becomes increasingly the focus of attention for ecological research. Regarding biodiversity loss, the gap in mechanistic understanding of community dynamics complicates the prediction of community stability. This suggests that a better understanding of the effects of community composition and structure on community stability is crucial and appropriate methods are needed.

The evaluation of community-level stability in the light of environmental changes should comprise the whole community to take into account the strong influence of multi-species interactions. Deriving networks is an useful way to describe and quantify both species interactions and community structure. Information on species interactions are typically neglected by simply focusing on species richness. The importance of using species interactions as a response variable in order to adequately capture and monitor changes in community structure has recently been suggested by different study results. We represent a community as a three trophic-level interaction web of functional groups.

The proper definition of stability is a widely debated subject in ecology and its application generally depends on the experimental design and research question. We calculate community stability as reliability of its interaction web. This is the probability of the community (interaction web) to become fragmented, based on functional group vulnerability of a certain environmental change and community network structure.

Results suggest a considerable association of community stability with its complexity and structure given a certain environmental impact scenario.

E7-O6: How do climate and habitat quality affect the Large Heath (*Coenonympha tullia*)?

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The distribution and population size of the Large Heath, *Coenonympha tullia*, are strongly declining throughout Europe. In this study distribution and range dynamics in Germany are shown and were analyzed regarding climatic parameters. Overall, we focused on habitat and oviposition preferences, surveyed in fens and bogs in Southern Bavaria. Our results revealed that regional extinction of *C. tullia* populations in Germany is correlated with warm and dry climatic conditions. Habitat analyses showed that the abundance of *C. tullia* was best explained by the type of land-use and cover of host plants. In contrast to transition bogs and raised bogs, late mown fens had the highest density. Oviposition was determined by (i) the vegetation structure, partly correlated with this (ii) a warm and rather moist microclimate and (iii) the cover of host plants, i.e. *Eriophorum latifolium*. Oviposition habitats were characterized by a high possible sunshine duration, low vegetation density and height, but a higher cover of litter as in random sites. In order to achieve favourable microclimatic conditions females of *C. tullia* adapt the height of oviposition, to the cover of litter and the vegetation density near ground. For long-time survival of *C. tullia* the preservation and management by mowing late in the year of the preferred habitats, calcareous fens, is of crucial importance.

E7-O7: Temporal aspects of environmental change and the impacts on tri-trophic dynamics

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Climate change, as recently projected, is expected to have widespread impacts on wildlife species and populations. These effects might differ considerable, ranging from extinction, over range shifts and mismatches in phenology to changes in population and community dynamics. Most studies focus on single-species or populations and how they are affected by changing environmental conditions like changing temperature and precipitation or the predicted increase in extreme weather events. However, it is known that intra-and inter-specific interactions are crucial processes for the persistence of biotic systems. Key challenges include the need for an understanding of how responses at the vegetation level translate into higher trophic levels. In order to further explore this topic we developed an individual-based model of a tri-trophic community (resource-herbivore-predator) under climate change using the software NetLogo. Therefore, we utilized the extensive 50 year data-set of moose (*Alces alces*) and wolves (*Canis lupus*) of the Isle Royale National Park, Michigan, USA to incorporate individual characteristics like fitness as well as biotic interactions of the three trophic levels into the model. Focussing on the shifts of seasonal changes we examined: (i) how the temporal aspect of climatic changes influences individual fitness and (ii) how that translates into the dynamics of the tri-trophic system.

E7-O8: Impacts of climate change on large mammals and tourism in African national parks

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Whereas the impact of climate change on single species has been studied rather well, the effects on trophic interactions, ecosystem functions and ecosystem services are little understood. It is particularly difficult to quantitatively link climate change, changes in biodiversity, ecosystem functions and services. Previous studies are largely based on some of these links or on qualitative assessments.

African savannah ecosystems are an interesting study system for understanding the relationships between climatic factors, biodiversity, ecosystem functions and services. They harbour a unique diversity of large mammals and additionally provide important ecosystem services, e.g. wildlife tourism. Savannah national parks with high densities of well visible large mammals are the basis of Africa's nature-based tourism. Climatic factors, vegetation, densities of ungulates and large mammalian predators and tourism are assumed to be intricately linked.

So far, only specific links among these factors have been studied while causal relationships among all components, including tourism have not been tested quantitatively.

The main aim of this study is to test and better understand the relationships between climatic factors, large mammals and tourism. We will focus on African national parks in savannahs of southern and East Africa. To test these relationships we will use path models which are effective tools to reflect and visualize complex systems, interactions and causalities. We hypothesize that climatic factors have significant effects on this system with high temperatures decreasing and high rainfall increasing ungulate densities, predator densities and thus tourist numbers. We hypothesize that indirect effects of climatic factors on predators and tourists via ungulates are more important than direct effects which was confirmed by preliminary results across 17 African parks. Our results suggest that climate change might have severe impacts on this system.

E7-O9: Mechanistic understanding of linkages between structural and species diversity

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The relationship between spatial environmental heterogeneity across scales (i.e. structural diversity) and species diversity is one of the principal concepts of population and community ecology, but this concept still lacks a mechanistic basis. The inherent complexity of how habitat heterogeneity, habitat loss or fragmentation affects animals at the level of individuals, populations and communities remains a key challenge for ecologists. This in particular holds given the limitations of experimental studies at the landscape scale, the broad range of behavioural pattern and the varying, species-specific perception of habitat structures and spatial scales.

Here we present and discuss different empirical and modelling approaches and examples that aim at a better understanding of the relationship between structural and species diversity following a bottom-up approach, i.e. trying to scale up individual responses to (changing) habitat structures to the population or community level. A better understanding of such linkages is the key to better predict responses of animal diversity (including genetic diversity) to environmental changes and builds a crucial basis for future successful conservation management.

Poster Presentations

E7-P1: Phenotypic trait variation of two forest herbs along a latitudinal gradient

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Phenotypic plasticity is the ability of an organism to express different phenotypes under different environmental conditions. It may buffer individuals both against short-term environmental fluctuations and the long-term effects of global change. A plastic behaviour in response to changes in the environment may be especially important in species with low migration rates and colonization capacities. Latitudinal gradients can be used as a proxy for differences in temperature and as a space-for-time substitution in order to predict the response of plant populations to climate change. In this study, which is conducted in the framework of the FLEUR project (www.fleur.ugent.be), we compared the phenotypic trait variation (used as a measure for the amount of phenotypic plasticity) of two perennial forest herbs, *Brachypodium sylvaticum* and *Milium effusum*, along a 2500 km latitudinal gradient from Central Italy to Central Sweden / Norway (2 species × 10 regions × 6 populations × 30 individuals). In addition, we assessed local environmental conditions in terms of soil parameters and canopy cover in all populations. Our first results show how large-scale environmental conditions (e.g. differences in temperature) as well as small-scale site conditions (e.g. soil, light) affect the phenotypic variability of vegetative and reproductive traits in *B. sylvaticum* and *M. effusum*.

E7-P2: How does a regional climatic gradient affect vegetation of floodplain meadows?

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Floodplain meadows are highly productive ecosystems located in the transition zone between terrestrial and aquatic ecosystems. Thus, several studies focussed on effects of hydrology and land use on species distribution and diversity of floodplain meadows, whereas effects of climatic conditions on floodplain meadows are poorly investigated yet. As climate is an important driver determining plant distribution ranges, the aim of this study is to detect differences in vegetation composition and diversity in floodplain meadows along the regional climatic gradient at the Middle Elbe River. For this purpose, 55 vegetation plots were sampled at six study sites in two habitat types (wet and mesophilous grassland). Study sites are located in the Middle Elbe Region along the East-West climatic gradient. Data were mainly analysed by multivariate statistical methods. The results showed differences in species composition of floodplain meadows along the Middle Elbe River due to climatic factors. While temperature and precipitation were found to be important predictors of species composition in wet grasslands, the number of frost days was found to have an impact on species composition in mesophilous grasslands. Diversity (Shannons Evenness and species number) mainly showed differences due to flooding duration. Increasing temperature, as predicted by climate change scenarios, may lead to shifts in the distribution range of floodplain species, particularly in wet grasslands along the Middle Elbe. In mesophilous grasslands, the predicted decrease in frost days may lead to changes in competition and interactions among plants and thus finally to changes in species composition and diversity. However, possible effects of climate change on vegetation of floodplain ecosystems are difficult to predict because of the complex interactions of environmental factors in floodplain ecosystems.

F1 Coastal Ecology

Oral Presentations

F1-O1: Effects of CO_2 and tides on growth and photosynthesis of *Fucus vesiculosus*

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Marine macroalgae are important components of coastal ecosystems. They contribute significantly to coastal primary production and provide food and habitat for numerous organisms. Due to rising atmospheric CO_2 concentrations the global oceans become more acidic. This might affect photosynthesis and growth of seaweeds with potential implications for entire coastal ecosystems. Intertidal macroalgae are not only exposed to increasing CO_2 concentrations but also to severe fluctuations in their abiotic environment due to the diurnal tidal cycle. The aim of this study was to provide understanding of the combined effects of ocean acidification and tidal emergence on the intertidal brown seaweed *Fucus vesiculosus*. Thalli of *F. vesiculosus* were cultured at two different CO_2 concentrations (280 and 700 ppm) and two different tidal regimes (tides and no tides) and displayed clear responses to the interactive effects of pCO_2 and tidal emergence. Growth was enhanced in algae grown at high pCO_2 and tidal emergence whereas photosynthesis remained unaffected. This indicates that photosynthesis of *F. vesiculosus* is already saturated at present CO_2 concentrations due to an effective carbon concentration mechanism. The Chl *a* content of the algal tissue decreased at high pCO_2. The non-photosynthetic enhancement of growth might result from a re-allocation of energy which is gained by metabolizing photopigments. The results of this study clearly demonstrate the importance of the interactions of multiple environmental factors in studies on the responses of marine macroalgae to ocean acidification. This work adds a new aspect to the ongoing research of the effect of ocean acidification on marine seaweeds. The results will help to predict the future performance of intertidal seaweeds and possible implications for coastal ecosystems in a changing ocean.

F1-O2: Which environmental factors control development of salt marsh vegetation types?

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After the foundation of the Wadden Sea National Park of Schleswig-Holstein in 1985, intensive sheep grazing was abandoned on large parts of the salt marshes. Consequently, spatial distribution of vegetation types has significantly changed. Based on analysis of large-scale

monitoring data of the mainland salt marshes, we aimed to answer the following question: i) Which environmental factors control together with the grazing regime the development of the abundant vegetation types *Festuca rubra* and *Puccinellia maritima*?

Using GIS we quantified main transitions for both the *Festuca*-type and the *Puccinellia*-type in three time steps, 1988-1996 (TS 1), 1996-2001 (TS 2) and 2001-2006 (TS 3). The impact of grazing-regime, elevation, neighbouring vegetation and large-scale spatial gradients of sedimentation or tidal range on vegetation type transitions was analyzed by the calculation of classification trees (CART) in each time step.

The grazing regime looses explanatory power for observed *Festuca*-type transitions to the benefit of elevation from TS 1 to TS 3. Short distances to *Elymus athericus*-type patches (TS 1) and elevation > 2.20 m (TS 2) seems to enhance transitions to the *Elymus*-type that finally spreads in the *Festuca*-type across all grazing categories (TS 3).

Considering the *Puccinellia*-type transitions elevation is most important for their explanation in TS 1 while in TS 2 and 3 the impact of grazing regime increases. Occurrence of no change in vegetation type and transitions to the *Festuca*-type strongly decrease in long-term ungrazed areas. Increase of transitions to *Elymus*- occurs mainly in ungrazed areas.

To conclude primarily a combination grazing-regime and abiotic conditions, represented by elevation and the spatial position of vegetation type patches drives vegetation development. Based on these results implications for future salt marsh management will be discussed.

F1-O3: Grazing management of salt marshes: effects of cattle and horses on *A. tripolium*

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In coastal salt marshes, both the absence of grazing and intensive grazing generally lead to a homogenous canopy. Intermediate stocking densities on the contrary, often results in vegetation with a diversified structure and a higher plant-species diversity. The question what grazing regime is most appropriate to reach certain conservation goals remains unanswered.

This study shows that management with different livestock species (cattle and horses) and different densities (0.5 and 1.0 animal/ha) lead to different outcomes.

Four different grazing regimes were applied in a grazing experiment on a clayey salt marsh. During focal observations the spatial distribution and diet composition of the animals were monitored. *Aster tripolium* is a characteristic and important salt marsh species, and to study the effects on the ecosystem we monitored 500 individuals of this plant species.

Horses utilized the whole area, whereas cattle tended to stay on the higher marsh close to the water supply. Cattle consumed significantly more *A. tripolium* than horses. The high stocking densities led to a higher rate of damage in plants. In the low stocking densities, the plants were significantly more damaged by cattle than by horses, whereas in the high densities we found the opposite. In the low-intensity cattle-grazed areas, the plants were also damaged earlier in the season than in horse- grazed areas. The number of flowers was significantly affected by the grazing regime.

We proved that livestock type and stocking densities can lead differences in timing, intensity and consequences of damage of *A. tripolium*. The observed differences between the two livestock species in spatial distribution and diet composition explain a large part of the results. We conclude that livestock type and density have an effect on *A. tripolium* and should thus be considered in management decisions.

F1-O4: Salt-marsh restoration: Temporal and spatial sedimentation pattern and grazing

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Salt-marsh elevation sets an ultimate limit to sediment accretion. Other factors such as distance to sediment sources, vegetation structure and storm incidence may be considered as additional factors affecting sediment accretion in both space and time in a more proximate manner. Creeks are a transport path for sediment to a salt marsh, and in this respect creeks also act as a sediment source.

Restoration of salt marshes often comprises de-embankment of polder by breaching the seawall and restoration of a creek system. This study focuses on the effects of the breaches, creeks and storm frequency on sediment accretion. Our study area was a former summer polder that was de-embanked for salt-marsh restoration and an adjacent existing control salt marsh, on the Wadden Sea mainland coast in the Province of Friesland, the Netherlands. The summer dike was breached and three artificial creek systems were built. Furthermore the area was summer grazed with livestock. The development of the polder into a salt marsh was studied over several years. The effect of grazing on net elevation change was studied with exclosures.

Creeks had a strong positive effect on net elevation change, and consequently levee formation began in the formerly flat polder area. Compared to creeks, the proximity of breaches was a weak factor in the explained variance of sediment accretion. On a yearly basis, net elevation change had a strong positive relationship with the storm conditions. Livestock grazing had a negative effect on both sediment accretion and net elevation change. In comparison with the ungrazed controls inside the exclosures, soil compaction was much higher in the grazed area. The restored salt marsh had a lower initial elevation than the more seaward located control salt marsh. This lag in elevation development was enlarged, since sediment accretion was lower in the restored salt marsh than in the control salt marsh. Consequences for the restoration potentials will be discussed.

F1-O5: Habitat mappings of tidal basins: challenges and methodologies

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Reliable habit mappings are an important basis of describing and analysing landscape patterns, diversity, and dynamic. Due to conceptual as well as methodical challenges, mappings of habitats in high resolution and promptly, describing seascapes offshore and – especially – near shore, are seldom and, compared to their landside counterpart, of minor quality.

Mappings of benthic macro-fauna from the highly dynamic sites of the intertidal and sublittoral backside mudflats in the Wadden Sea have to deal with poor data on topographies, sediments, and currents. Thus, these parameters are most unquestionably the main drivers for choice of location and thus of community patterns.

This contribution discusses common approaches of seascape-mappings of the German Bight up to the tidal basins of the Wadden Sea. It presents a modelling-concept to downscale existing approaches and to integrate this workflow in the framework of an environmental information platform. The feasibility of model-driven habitat mappings for environmental management and ecological analysis will be evaluated. Eventually the reliability of existing habitat mappings for the analysis of ecosystem functions and services will be outlined.

F1-O6: Analysing causes of habitat separation of Idotea spp. based on population models

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The isopods *Idotea baltica*, *I. granulosa* and *I. pelagica* are common in seaweeds of the intertidal zone of Helgoland, North Sea, where they occur in separated habitats along a tidal gradient. We assumed this to be an effect of size-dependent inter- and intraspecific competition. In other words we assumed that the potential population structure of each species varies along the gradient as a consequence of varying reactions to prevalent environmental conditions. In comprehensive laboratory experiments at the AWI, Helgoland (Hammrich, unpublished) the reaction in growth, mortality and reproduction to tidal and nutritional conditions was studied. Based on the resulting data set we developed models which allowed us to analyse the above assumptions. At first, we identified the most efficient process model for each species and each environmental condition from a set of concurrent and hierarchical models. For instance, life-cycle specific rates were required to explain growth under certain nutritional conditions. Furthermore, we combined those process models to size structured population models and studied the potential abundance along a tidal gradient. Finally, we simulated diverse competition scenarios.

F1-O7: The role of marine inflow on coastal terrestrial communities

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A major factor structuring coastal communities is cross-ecosystem flow from the marine to the terrestrial system, or vice versa. The inflow into the terrestrial part of the coastal system consists of algae that are deposited on the shore, faeces from fish-eating birds and arthropods emerging from the sea. These inflows may both add nutrients to plants and cause increased resource densities for higher order consumers. We have used stable isotope analyses to delineate food webs in shore-line ecosystems, showing that chironomids is a major source of food for terrestrial predators on Baltic sea shore-lines. There are however niche differences between terrestrial consumers and the main benefactors of marine inflow are various spiders whereas terrestrial insect predators are mainly dependent on the terrestrial productivity. This selective use of marine resources has the consequence that spiders show large increases in density in shore-line ecosystems, and through exclusion experiments we have shown that terrestrial insect predators are further reduced on the shore through intraguild predation from spiders. The effect from marine inflow is mainly restricted to the near shore, but our studies suggest that some effects may extend further inland. Surprisingly, these effects are quantitatively similar in fairly different systems. When comparing effects between beaches in Australia and forested shores in the Baltic regions, we find a very similar extent of the marine inflow. The similarity occurred despite the huge differences in productivity between systems and the cause seem to be the similarity in vectors. In the talk, I will provide an overview on the inflow mechanisms and the effects that marine inflow has on the terrestrial coastal system and also contrast different types of inflow.

F1-O8: Grazing, vegetation and breeding birds on marshes of the Wadden Sea coast

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The effects of grazing management on breeding birds have been debated for years. Here we present a study based on data collected over a period of almost 20 years and provide some nuances to the debate. We find that the percentage cover of tall vegetation on a marsh is a good indicator of livestock densities on that marsh. However, we do not find straightforward effects of grazing on bird diversity or bird numbers in general. Instead we find that the relation between grazing and bird numbers is dependent on the type of marsh (salt or brackish) under investigation. We ascribe these different relationships to within survey area differences in the distribution of tall vegetation over a marsh.

We conclude that, no matter what the effects of grazing on birds, grazing provides a tool for managers to decrease the cover of tall vegetation. Managers in charge of nature conservation

should therefore always consider their goals and the effects of a decrease in tall vegetation before implementing a grazing regime.

Poster Presentations

F1-P1: Tracking ecosystem changes in Tidal basins - a guide for management and policy?

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Achieving a “Good environmental status” in European water bodies is the key aspect of European legislation in the recently adopted Marine Strategy Framework Directive and the Water Framework Directive. Policy and management are therefore increasingly obliged for analysis, comparisons and evaluation of the environmental status of natural habitats, e.g. the subtidal and intertidal areas of the estuaries, bays and basins of the Wadden Sea.

Comparing all 39 tidal basins in the Wadden Sea Area (WSA) evaluating similarities and differences in their abiotic features, ecological developments and the policy and management strategies applied there will achieve a better understanding of the cause-effect relationships within these three elements. Main objective of this study was to elucidate the relevance and feasibility of comparing the entire Wadden Sea area as to its tidal basins, as well as the availability of necessary data for each of these basins.

By means of significant key-questions for management and policy the survey assessed the availability of environmental data for the tidal basins of the WSA, discussed the feasibility of that data for a scientific analysis of the ecological, physical and chemical status of the basins, and briefly analysed corresponding policy, management and science topics. Additionally the usefulness of tidal basins for comparative research in the WSA was proven. They present logical units from a morphological, hydrodynamic, and ecological perspective and can be regarded as natural compartments of the Wadden Sea and its tidal flats. Their future comparison will provide insight into the ways natural and anthropogenic factors may influence the condition of the tidal basins environmental status including shifting biodiversity, human use patterns and climate changes such as sea level rise. Consequences for existing and future monitoring concepts in the German Bight will be highlighted.

F1-P2: Effects of climate change on the vegetation of tidal freshwater marshes

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Increasing temperatures due to climate change have already led to a northward movement in the distribution range of several plant species of the northern hemisphere. This study simulates the effects of increased temperatures and northward species migration on the vegetation of tidal freshwater marshes. For this purpose, we are using soil seed bank samples from six Atlantic estuaries, situated along latitudinal gradients in Europe and North America, in order to study patterns of germination, establishment, and species composition. The European latitudinal gradient includes sites at the Miño river (border between Portugal and Spain), the Loire river (France) and the Elbe river (Germany). The latitudinal gradient in North America comprises sites at the Waccamaw River (South Carolina), the Pamunkey River (Virginia) and the Connecticut River (Connecticut). In order to study the effects of temperature, the samples are exposed in mesocosms within greenhouse chambers that have different mean temperature regimes (a higher and a lower one). In order to simulate migration, soil seed bank samples within a continent are mixed and exposed to the same temperature treatments. In this way, the experiment includes the effects of increased temperature on the vegetation of tidal freshwater marshes with and without migration. We hypothesize that the vegetation from the northern estuaries responds more under the increased temperature regime than the vegetation from the southern estuaries, and that with migration the southern species become more dominant under increased temperatures.

F1-P3: Hydrodynamics - Its effect on habitats of reed species along North Sea estuaries

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The ecology of the North Sea estuaries and their marshes is formed by rivers' freshwater discharge and tides. As a result, different environmental gradients exist. Beside the gradients of cycles of matter, gradients of hydrodynamics range over the estuary funnel, its width and water depths. Marshes are permanently exposed to hydrodynamics such as tidal range, current velocity as well as wind and ship waves. Therefore, marsh habitats are influenced by these variables. Estuarine vegetation is important for the sustainable development of tidal river systems. Besides its role for nature conservation, tidal reeds act as ecosystem engineers e.g., they accumulate sediments and reduce the hydraulic energy impact on river banks.

Because of climate change, hydrodynamics will most likely alter due to sea level rising and more frequent storms. Based on the response how reed habitats will change under altered hydrodynamic conditions, we will create options for adaptations for preservation of the reed species and its functions. Before this, the following research question has to be studied:

Is there a significant effect on habitat niches of reed species along marsh edges due to different mudflat widths as a morphological element reducing wave energy?

Presence data of three reed species *Phragmites australis*, *Bolboschoenus maritimus* and *Schoenoplectus tabernaemontani* along Weser and Elbe marsh edges are extracted from a reed type map in a scale of 1: 5000. These data are combined with the data of mudflat widths in front of the reed by GIS analyses. Based on an analysis of variance preliminarily results will be presented.

F1-P4: A mechanistic population model for *Phragmites australis* in tidal marshes

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Natural river bank vegetation at tidal waterways provides important ecosystem functions and services such as offering habitat, filtrating solid and dissolved substances from the water as well as providing erosion control for the riverbanks. In many rivers, agriculture, hydraulic engineering and water management threaten the structure, species composition and functionality of tidal marshes. Global warming might entail additional risks, such as changes in water level and a higher frequency of extreme events. Therefore, a better understanding of the response of tidal marsh vegetation to the hydrodynamic tidal-regime is essential. We use mechanistic modelling for analysing the ecological processes determining distributional patterns. We furthermore aim to assess the impact of global warming on tidal marsh vegetation in the river Elbe in Germany, focussing on *Phragmites australis*. As the relevant processes and the optimum level of model complexity are hard to determine a priori, we in the first step, use a simple-to-complex approach by gradually adding more detailed processes and mechanisms to a basic cellular automaton. Potential processes to be included into the population dynamic model are dispersal, competition, adaptive plasticity and physiological integration; whereas potentially important habitat factors represent processes related to hydrodynamics, stress factors such as salinity and disturbances. The model will provide valuable insights into the relationship between habitat variability, ramet growth and reoccurring stable patterns of *Phragmites* distribution, and can foster an improved quantitative understanding of processes related to the dynamics and distribution of reeds.

F1-P5: Patterns and processes of population dynamics under fluctuating habitat size

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Population dynamics are determined by both density-dependent processes, such as competition, and density-independent processes, such as environmental fluctuation. Logistic growth model is the fundamental population model often used for analyzing effects of these processes on population growth rate. In the classical logistic model, however, it is not straightforward to describe the dynamics of a population in which habitat size is temporally variable because an implicit assumption of logistic model, the coherence between abundance and density, is no longer possible.

In this study, we developed a general population model in which changes in population abundance, density, and habitat size are taken into account to incorporate habitat size variability. We applied this model to population dynamics data of *Tigriopus japonicus*, a marine copepod inhabiting tide pools of variable sizes due to weather processes.

Field censuses were conducted at 36 tide pools in the supralittoral zone on an exposed rock reef in southern Hokkaido, Japan, from 6 May to 7 July 2003. We measured density of *T. japonicus* and water volume of tidepool at 2-day intervals. We fitted a hierarchically structured state-space model with a process model representing the dynamics of population abundance of *T. japonicus* and water volume at each tide pool and a data model representing the observation process of population density and water volume.

We found that (1) divergence in patterns of population abundance and density was related to the variability of habitat size; and (2) interactive effects of density-dependent processes and weather processes determine population growth of *T. japonicus* at multiple spatial scales. These results suggest that weather processes greatly influence the patterns and processes of *T. japonicus* populations via changing habitat size.

F1-P6: Basis for a long-term assessment of seal's diet within a changing environment

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Environmental changes in the North Sea induce a shift in abundance, distribution, recruitment and size of some fish species (Perry et al. 2005; Rijnsdorp et. al 2009). As this might lead to changes in the seal's preferred diet, it is important to learn more about the seal's food selection and availability in the North Sea. By preserving biodiversity, allowing coexistence and stimulating growth of their prey, harbour seals (*Phoca vitulina*) and grey seals (*Halichoerus grypus*) are one of the most important top predators in the North Sea. Indications for inter-specific competition among the seals and between seals and other fish-eaters have been found. As the number of seals in the North Sea is rising the risk for competition is increasing. In the nature reserve around Helgoland Island, where commercial fishing is prohibited, conditions to study the seals diet and to gain further insights in size structure and community composition of fish are ideal.

During the summers of 2008, 2010 and 2011 diet compositions of seals were determined from the analysis of faecal samples collected at haul-out sites. Around 18 fish taxa were found in scats during the first two sampling periods. The prey of both seal species mainly consisted of garfish (*Belonebelone*), dragonets (*Callionymidae*) sandeel (*Ammodytidae*) and flatfish (*Pleuronectidae*). Only sandeel, which is also eaten by other piscivores, and some flatfish species are important for commercial fishing in the North Sea. Differences in seals' prey composition found among the first two years are likely due to differences in water temperatures measured in 2008 and 2010. Preliminary results indeed show a broader spectrum of prey and higher quantities within each prey taxon in 2010 than in 2008. Possiblecauses could be differences in fish size/mass as well as differences in fish abundance. Further research is hoped to shed light on this.

F1-P7: Performance and gene expression of *Fucus serratus* in a changing ocean.

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The excessive combustion of fossil fuels since the industrial revolution has caused a substantial rise in atmospheric CO_2 concentrations. While a huge number of marine organisms are expected to suffer from the resulting ocean acidification, marine macroalgae might benefit from the enhanced availability of dissolved CO_2 in the seawater. Photosynthesis of many macroalgae is carbon limited under current CO_2 concentrations, particularly in intertidal species during periods of emergence. It is, therefore, hypothesized that enhanced atmospheric CO_2 concentrations will have positive effects on intertidal macroalgae. Currently the interactive effects of enhanced CO_2 concentrations and tidal emergence on the intertidal brown seaweed *Fucus serratus* are studied. Thallus pieces of *F. serratus* are cultured under two different atmospheric CO_2 concentrations (280 and 1200 ppm) and two tidal regimes (with and without tidal emergence). Somatic growth and photosynthesis are measured as indicators of algal performance. Additionally, photopigment (Chl *a*) and phlorotannin content of the algal tissue are measured. To understand the molecular processes underlying the algal responses, the expression of genes involved in CO_2 fixation and photorespiration will be studied by quantitative RT-PCR in algal individuals from the different treatment combinations. Growth and photosynthesis did not vary between *F. serratus* from different CO_2 concentrations and tidal regimes indicating a successful adaptation of the species to strong natural environmental fluctuations in the intertidal habitat. The biochemical and molecular analysis are in progress.

G1 Biological invasions: effects on ecosystem functions

Oral Presentations

G1-O1: Major hypotheses about invasive species fail the test of generality

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Invasive species threaten biodiversity and have numerous other direct or indirect effects on ecosystem functions. Major hypotheses about invasive species exist, but their general applicability is unknown, as they have never been evaluated using a standard approach across taxonomic groups and habitats. Such an evaluation is a critical step, as it can reveal research gaps, discriminate hypotheses with substantial support from those lacking support, and set priorities for future research. We performed a global literature analysis across animals and plants in terrestrial, freshwater, and marine habitats to evaluate six major hypotheses in invasion biology. We found that only half of the hypotheses are supported by >50% of available empirical tests: the invasional meltdown hypothesis, novel weapons hypothesis, and enemy release hypothesis. These hypotheses consider interactions of exotic invaders with their new environment, whereas the other hypotheses, which are supported by <30% of empirical tests, do not consider such interactions and focus solely on either invaders (tens rule) or characteristics of the new environment (biotic resistance hypothesis and island susceptibility hypothesis). We also reveal research gaps and show significant differences in empirical support among taxonomic groups and habitats. Our results expose the need to re-evaluate and possibly revise, or even discard, some of invasion biology's leading hypotheses.

G1-O2: Feedback between plants and soil biota in invaded ruderal plant communities

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Biological invasions are regarded to be one of the main drivers of biodiversity loss. Investigations of plant interactions with soil biota play an important role for understanding the mechanisms behind the successful spreading of invasive plant species. Plant-soil feedbacks occur when plants change soil community composition with positive or negative feedback

effects on their own performance. Experimental studies suggest that plant invasions may be promoted by stronger negative soil feedbacks for native compared with exotic plant species. However, exotic plants may also change soil community composition with negative or positive effects on native plant species. Here we examine whether one of the worldwide most successful herbaceous invaders, the Canada goldenrod *Solidago canadensis*, negatively influences plant growth and susceptibility to leaf herbivores of two coexisting native plant species (*Tanacetum vulgare*, *Melilotus albus*) mediated by changes in soil community composition. We collected soil beneath the three target species growing either on abandoned urban city sites or suburban forest sites where *S. canadensis* was the most dominant herbaceous plant species. We established 180 experimental pots in the greenhouse and transplanted seedlings of our target plant species either into their own soil (home soil) or into soil derived from the competitive invasive or native plant species (foreign soil). Our results show that *T. vulgare* has increased shoot growth in foreign soil derived from *S. canadensis* compared with its own soil suggesting a negative soil feedback or a growth promotion by the soil community of *S. canadensis*. Surprisingly, this effect differed in soils from urban or forest sites. Moreover, we could show that *S. canadensis* grows better in soils from forest areas than from city sites. We analyzed the community structure of soil inhabiting nematodes to see whether nematodes could play an important role in achieving positive or negative soil feedbacks.

G1-O3: Invasion of *Impatiens glandulifera* reduces ectomycorrhiza on *Fagus sylvatica*

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The invasive *Impatiens glandulifera* is known to reduce native plant species richness and to change plant-pollinator interactions in river systems. In the past decades, *I. glandulifera* started to invade forest ecosystems disturbed by wind throw or by intensive management activities. In forests, the symbiosis between ectomycorrhiza (EM) fungi and tree species plays a key role for survival and growth of trees, because EM fungi facilitate nutrient and water supply of its hosts and protect them from soil pathogens. We set up a field experiment to investigate the effects of *I. glandulifera* on the symbiotic association between EM fungi and *Fagus sylvatica* saplings, the most frequent deciduous tree species in Central Europe. We assessed EM colonisation and the number of EM morphotypes on *F. sylvatica* saplings planted in plots covered with *I. glandulifera,* in plots where *I. glandulifera* was removed and in control plots without *I. glandulifera*. Our study showed that the invasion of *I. glandulifera* in forests led to significant changes in the symbiosis between EM fungi and *F. sylvatica* saplings. EM colonization on *Fagus sylvatica* saplings growing in invaded plots was reduced by 65% after 15 months compared with saplings growing in removed and uninvaded plots. Similar effects were found for the abundance of EM morphotypes. Roots of *F. sylvatica* saplings hosted 15–43% fewer morphotypes compared to saplings in removed and uninvaded plots. The reduction in EM colonization and EM abundance on *F. sylvatica* saplings resulted in a reduced survival rate of young trees. Our study demonstrates that the invasion of *I. glandulifera* is a serious threat for the natural regeneration of beech forests. In the long term we expect a high economic loss in forestry, beside ecological impacts.

G1-O4: Ecosystem effects of a specialist herbivore for the control of Japanese knotweed

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Biological invasions can affect ecosystem functioning in a multitude of ways. However, new insect species and their impacts on native species often initially go unnoticed, potentially making the study of impacts difficult as pre-invasion data or uninvaded control sites may not be available. The aim of the introduction of classical biological control agents (BCAs) is to establish a host-specific, non-native species permanently to control the target weed in a large area in eventual equilibrium. There are hardly any examples of unexpected effects of weed BCAs on native plant species, illustrating the specificity of the herbivore-plant interaction and the safety of classical biological control of weeds, but the impact of insect weed BCAs on native invertebrates is rarely studied. In 2010, the psyllid *Aphalara itadori* (Homoptera: Psylloidea) was released in England as a classical BCA against Japanese knotweed. This is the first project of its kind in Western Europe and it provides a rare opportunity to study ecosystem impacts of a newly established specialist insect. A 5-year monitoring study has begun to record the efficacy of the insect as a BCA and its population development, but also any potential "non-target" impact on the native ecosystem. Hence, with this study we specifically aim to record changes in the native invertebrate community as a result of the introduction of a new specialist herbivore insect species. The abundances of all organisms >2 mm in 26 orders and suborders are recorded to assess the dynamics of herbivores, predators and parasitoids, as well as detritivores. In this talk we present the design of the ecological monitoring study, one of the most detailed studies of its kind. We show data from the first two years to illustrate how the data obtained through intensive and detailed monitoring of the invertebrate community may reveal changes in ecosystem functioning, such as the restoration of native species assemblages after successful control of Japanese knotweed.

G1-O5: Ecological preferences of alien plant species in North-Eastern Germany

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Biological invasions are called a major threat to biodiversity and ecosystem functioning. Based on the comprehensive vegetation database of Mecklenburg-Vorpommern/NE Germany with 51,328 survey plots we studied the level of invasion of an entire regional flora with 133 non-native plants (NNP, immigration after 1492 AD) with regard to their preferences to all kinds of habitats and along different ecological gradients.

For each plot, we computed average Ellenberg indicator values (EIV) for temperature, light, moisture, reaction, nutrients and salt as well as plant strategy type weights. We studied the relative frequency of plot averages with and without occurrences of NNP along the gradients.

Due to the preferential sampling of the database and because of the potential bias of EIV values we had to design a sophisticated analysis to ensure reliable results. We identified deviations from random differences by testing against permuted indicator values. To account for potential bias in EIV between community types, NNP preferences were differentiated by phytosociological classes. NNP as a group prefer communities with high EIV for temperature and nutrients and low EIV for moisture. They avoid communities with low EIV for reaction and high EIV for salt. NNP prefer plant assemblages with high proportions of ruderal and low proportion of stress strategists. The differentiation by phytosociological classes reinforces the general trends for temperature, nutrients, moisture, R and S strategy types. Nevertheless, the preferences of individual alien species reveal that NNP are not a congruent group but show individualistic ecological preferences. We discuss the results in the light of two ecological theories, the fluctuating resource availability theory of Davis et al. (2000) and the filling of vacant niches by Moles et al. (2008).

G1-O6: Urbanity modifies ecologic dissimilarity between native and non-native woodlands

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Invasive *Robinia pseudoacacia* (black locust) is known to cause pronounced changes in native plant communities. The effects of this ecosystem engineer may be further modified by environmental variables but detailed analyses are as yet missing. In this study, we assessed the impact of the urban matrix on the Bray-Curtis dissimilarity within 34 pairs of black locust and native birch woodland plots in the city of Berlin. Different components of the urban matrix in a 500-m buffer around the plot pairs proved to have contrasting effects on the dissimilarity of the herb and shrub species in the two woodland types. Bray-Curtis indices significantly increased with the proportion of paved area, railway lines as well as ruderal- and grassland and decreased with the proportion of roads and Hansky connectivity between birch and black locust. Although there was no overall difference in the percentage of non-native species among both woodland types, dissimilarity of this species set was positively related to the proportion of ruderal- and grassland as a pool of native species. In contrast, we found a significantly higher proportion of nitrophytes in black locust, but Bray-Curtis indices in this species set did not clearly respond to the urban matrix. Overall, this study highlights the relevance of disentagling the components of the urban matrix to better understand the effects of non-native species on biodiversity in large cities. We found combined influences of seed sources (e.g. ruderal- and grassland) and dispersal vectors (e.g. roads) which determine the differences in species composition among urban woodlands. Similar factors may be expected in many invasive species and may explain contrasting biodiversity patterns in other urban areas.

G1-O7: Tracing the spatial impact of an invasive Acacia on native species N budgets

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The exotic N_2-fixing *Acacia longifolia* is highly invasive in Mediterranean dune systems. In the presence of this invader, ecosystem structure and functioning in terms of carbon, water and nutrient balance of the native system are substantially altered (Rascher et al. 2001, Rascher et al. in press, Hellmann et al. 2011). However, nothing is known about the spatial dimension of the invader's impact on the surrounding vegetation. We studied the influence of *A. longifolia* presence on N dynamics of the native endemic shrub *Corema album* by analyzing *C. album* leaf δ15N and N content on a spatial scale in a nutrient-poor Portuguese dune system. *C. album* leaf δ15N values showed a clear spatial pattern related to the presence of *A. longifolia*. Leaf δ15N values increased significantly from -11‰ to values close to 0‰ as a function of distance to the invader's canopy, giving evidence that *A. longifolia* enriched the system with atmospherically derived N (δ15N ~0‰). N dynamics of *C. album* were markedly altered even beyond the canopy range of *A. longifolia* stands. The threshold of influence modelled based on *C. album* leaf δ15N reached up to 8 m into the uninvaded vegetation and was furthermore shown to be ecologically highly significant, as within this area, native species diversity tended to decline and community composition was markedly altered (Hellmann et al. 2011). Our work highlights that applying the 15N natural abundance method on a spatial scale (ISOSCAPES) can lend valuable new insights into within-system N dynamics. We show that δ15N closely traces the influence of an N2-fixing invader on N traits of native species. As adverse effects on the native ecosystem are substantial, these findings are relevant for restoration efforts, since the area affected by invasion exceeds the physical extent of the invader by far.

G1-O8: Japanese knotweed vs. its hybrids: Comparing effects on plant species richness

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As one of the 100 worst invasive species in the world *Fallopia japonica* s.l. forms huge monocultures by outcompeting the natural vegetation. One of the central mechanisms responsible for *Fallopia*'s high competitive ability is the reduction of light due to its large leaves, fast growth and the building of dense stands. *Fallopia japonica* forms a hybrid with *F. sachalinensis*, which is thought to be even more aggressive than its parental taxa. We studied the passage of light, habitat characteristics and plant species richness within and outside stands of the three taxa *F. japonica, F. sachalinensis* and their hybrid *F.* x *bohemica* in Rhineland-Palatinate (SW-Germany). For identification genetic analyses using microsatellite markers were carried out. The results show that genetic analyses are urgently needed, as the morphology of backcrosses of *F.* x *bohemica* with *F. japonica* is extremely similar to that of *F. japonica*. Habitat characteristics of the different taxa did not differ significantly. Reduction of light due to the dense stands was high in all three taxa and the hybrid did not reduce light availability to a larger extent as compared to the parental species. The identity of the surrounding natural community plays a larger role in the reduction of species richness under *Fallopia* as compared to the impact of the different taxa. In this study the hybrid *F. x bohemica* seems not to have higher competitive abilities.

G1-O9: How complex is complex enough? Impact models of invasive plants

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Impact assessment of non-native species is becoming increasingly important for identifying high-impact species and setting management priorities. Recent studies have shown that relationships between invader abundance and ecosystem traits are modified by environmental co-variation and may take non-linear forms. Further, effects of invasive species can vary among ecosystem components. Regarding diversity, for instance, some species groups are adversely affected, while others might even be facilitated. Therefore, simple linear models are unsuitable for impact assessment of biological invasions. We modelled effects of three invasive plants (*Heracleum mantegazzianum*, *Lupinus polyphyllus*, *Rosa rugosa*) on species richness of invaded communities using both simple linear effect models and more complex (non-)linear models including environmental co-factors. These models were calculated for total richness of vascular plants and for different plant species groups. Then, we calculated impact scores for each invasive species as the average reduction of species richness predicted by basic and full effect models. All three non-native species had adverse effects on species richness, but there was also significant influence of habitat types. Impact scores were overestimated by basic effect models for *H. mantegazzianum* and *R. rugosa* due to disregard of habitat effects and non-linearity, respectively. In contrast, impact of *L. polyphyllus* was underestimated by the simple model that did not account for the strong interaction of invader and habitat type. Impacts varied among species groups. In general, early-successional species were more strongly affected that later-successional ones. We conclude that simple linear models often yield inaccurate impact scores of non-native species. Hence, effect models should consider environmental co-variation and non-linearity of the effects of biological invasions on native ecosystems.

G1-O10: Divergent responses of an invasive plant to native AM fungal assemblages

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Arbuscular mycorrhizal (AM) fungi are known to provide a variety of mostly beneficial services, predominantly phosphorus uptake, to their plant partners in exchange for carbon. It has been suggested that selection pressure in mycorrhizas may favour the AM fungi-plant combinations that are the most fit under their respective local environmental conditions, promoting local

adaptation in AM associations. Recently, existence of locally adapted plant-AM fungal interactions has been found, but knowledge of to what extent such adaptations may also occur during plant invasions is lacking. Here, we investigate whether or not *Ambrosia artemisiifolia*, a highly mycorrhizal plant, may be locally adapted to AM communities in the new European range. In a 'home vs. away' reciprocal inoculation experiment, we compared performance of plants from two different sites (a roadside and a field habitat), and showed how AM communities function in their own soil context and when they are introduced to naïve soils. The results indicate that responses of most measured plant growth variables, and reproductive as well as root architecture traits, were differently influenced depending on the origin of the AM fungal community. Interestingly, the combination of field soil treated with field ('home') inoculum had a negative effect on plant performance. We found no evidence for local adaptation between plant populations and their respective 'home' AM communities. Our findings contribute to a better understanding of the role of AM associations for the invasion success of *A. artemisiifolia* on the population level. Furthermore, the study demonstrates the importance of understanding the ecological context of study organisms in AM research, and suggests implications of using foreign inoculum in restorations.

G1-O11: No evidence for genetic adaptation of alien plants along an elevational gradient

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Mountain ecosystems have not been affected heavily by plant invasions yet. However, recent studies have shown that an increasing number of non-native plants are able to reach higher elevations. These species might threaten the natural mountain ecosystems and knowledge about potentially invading species is necessary to implement preventive conservation measures.

Determining the factors that limit the spread of non-native plant species is important to understand and predict their current and future distribution ranges. In our study, we focused on elevational gradients and investigated whether growing season temperatures explain the upper distribution limit of non-native plant species. Additionally, we wanted to find out, if the target species show a high level of phenotypic plasticity or if genetic changes have occurred. Both responses have been shown to allow non-native species to occupy a broad environmental gradient. We recorded the occurrence of nine non-native species in the Swiss Alps along several elevational transects and subsequently conducted a climate chamber experiment to analyze growth rates of plants from low and high elevations under different climate treatments. Almost all species reduced their growth under lower temperature in a similar way and growth responses to cold temperatures could not explain why some of the observed elevational limits are well-defined at a certain elevation after the species has been continually present along the gradient. For most species we did not find indications for genetic differentiation among populations. Thus, we conclude that factors other than growing season temperatures, such as extreme events or winter mortality might shape the elevational limit of

non-native species and that ecological filtering might select for those genotypes that are phenotypically more plastic.

G1-O12: Garden waste deposits as a source for invasive plants in mixed-deciduous forests

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The huge number of ornamental plants growing in public parks and private gardens is generally considered a potential risk for the spread of non-native species into natural habitats. We examined whether illegal garden waste dumping (deposition of senescent ornamental plants and garden clipping) in mixed-deciduous forests is a source for the spread of non-native plants in the surroundings of Basel, Switzerland. We assessed species richness and abundance of plants belonging to the ground vegetation at 20 sites with garden waste dumping and at 20 control sites. At single sites, 0.1–12.5 m^3 (mean: 2.6 m^3) garden waste was dumped per month resulting in a total amount of 2.2–35.8 m^3 (mean: 17.8 m^3) waste deposited over a period of 1 year. 37 of the 146 plant species recorded were non-native to Switzerland. All 37 non-native species were found in waste disposal sites, but only three of them in control sites. Thus, garden waste dumping sites harboured a larger number of non-native plants species than control sites, but the two groups of sites did not differ in number of native species. Garden waste dumping also altered plant species composition: larger proportions of non-forest species, of therophytes and of species with autochorous seed dispersal were recorded in disposal sites than in control sites. In the study region, garden waste is regularly removed by the foresters. However, our study shows that numerous non-native horticultural plant species escape from dumping sites and colonize the forest. It is concluded that there is an urgent need to increase the awareness of the garden owners concerning the problems associated with garden waste dumping.

G1-O13: Endemic habitat specialists vs. invasive generalists: Habitat and population

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Degradation and habitat loss on oceanic islands are key processes leading to population decline of endemic birds and facilitating the establishment of invasive bird species. In this study, we assessed density and habitat selection of two endemics and two alien landbird species of Robinson Crusoe Island. Results show that perturbed habitats contained a low density of two endemic birds (Juan Fernandez Firecrown and Juan Fernandez Tit-Ttyrant), whereas the invasive Green-backed Firecrown (and Austral Thrush) were significantly more abundant in perturbed shrub habitats. Landbird species show different habitat selection patterns, with endemics selecting for native forest and invasive species selecting for perturbed habitats, or

using them at random. Landbird species experienced temporal fluctuations in their overall population sizes, with the endemic Tit-Tyrant suffering a significant decline in its population size of about 63 percent between 1994 and 2009. Only invasive species exhibited temporal changes in habitat use, significantly reducing their densities in the preferred scrub habitats, possibly as a response to decreased habitat quality. Thrushes apparently were able to compensate the population decrease in one non-native habitat type by using native forests, a habitat giving them the opportunity of preying on nests of endemic species.

G1-O14: The risk of marine bioinvasion caused by global shipping

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During the last few centuries thousands of invasive species have dispersed beyond their native ranges and have transformed marine ecosystems around the world. In the past decades this world-wide dispersal of species has increased by orders of magnitude, with some regions being invaded by several new species per year, now recognized as one of the greatest threats to marine biodiversity. The globalization of maritime trade plays a key role in this accelerated spread of species because many of them are dispersed around the globe by cargo ships.

In this presentation, we combine empirical data about global cargo ship movements with port environmental conditions and biogeography to develop a model of marine bioinvasion by world-wide ballast water exchange. For every port call of a large vessel we calculate the likelihood of new invasions from a large pool of invaders at previous stopover sites. Thereby the model simultaneously integrates propagule pressure (i.e. global shipping), invasibility (i.e. habitat matching) and community mismatch (i.e. biogeographic dissimilarity). The model predicts high-risk invasion pathways, hot spots of bioinvasion, and major source regions from which bioinvasion is likely to occur, and allows to classify coastal ecoregions with respect to total invasion risk and risk composition from other regions. Our predictions agree with observations in the wild and reveal a generic pattern that the invasion risk is highest for intermediate geographic distances between donor and recipient ports. Finally, the model can be used to study the effects of risk reductions by ballast water treatment, suggesting that our approach may serve as a basis for the development of effective, and targeted, bioinvasion management strategies.

Poster Presentations

G1-P1: A systematic comparison of invasive species' impacts

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Invasive species can cause serious economical losses, are an important threat to biodiversity, and have other impacts on ecosystems. Although many studies have investigated the consequences of certain invasive species, there is a lack of systematic comparisons of invasive species' impacts across habitats and taxonomic groups. Based on published information, especially the Global Invasive Species Database (GISD), we extracted and categorized impacts of 127 invasive species that invaded different regions of the world. These species were selected based on availability of relevant information. We classified impacts as either "ecological impacts" or "direct impacts on human society", both with several sub-categories. We compared these impacts across habitats (terrestrial, freshwater, marine) and taxonomic groups. Our results for ecological impacts of invaders in different habitats show that terrestrial invasive species have more interactions with other invaders than freshwater invasive species. Terrestrial invaders also affect endangered species more often than those from freshwater habitats. Direct impacts on human society also vary for invaders from different habitats: Compared to terrestrial species, freshwater invaders less frequently cause harm to agriculture but more frequently cause impacts due to fouling. We also found significant differences in impacts across taxonomic groups. Further comparisons are planned, e.g. we will investigate how impacts vary for invasive species with different introduction pathways. This project will hopefully advance our understanding of invasive species' impacts across habitats and taxonomic groups.

G1-P2: Losing an advantage over time? Not in case of *H. mantegazzianum* phytotoxicity

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Recovery of native plant communities in invaded sites is likely to increase over time. This is because exotic invaders may accumulate pests or decrease their phytotoxin production in more advanced invasion stages, and thus lose their initial advantage over residents. In this study we investigated whether the performance of native plants grown in soil from sites invaded by *Heracleum mantegazzianum* (giant hogweed) may depend on the age of hogweed populations (including populations established only recently up to those older more than 50 years). We hypothesized that soil collected in older populations will have smaller phytotoxic effects than soil from sites colonized more recently. We also expected more negative effects of soil from younger populations due to more altered microbial communities. Sampled soil was

treated by i) the elimination of soil microbiota by gamma irradiation, ii) addition of activated carbon, iii) combination of both treatments and iv) none of these (control), and used in common garden experiment with sown native plants. Biomass of native plants was higher when grown in soil with eliminated microbiota irrespective of hogweed population age. Interestingly, phytotoxic effects of hogweed soil increased with the age of invader populations but only in the absence of soil microbiota. Thus, in opposite to what we expected, the recovery of native communities may be hindered at sites with longer invasion history due to increased allelopathy. Its effect may however be significantly modulated by the soil microbiota.

G1-P3: Trait divergence in native jewelweed after invasion of an exotic congener

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Although it is assumed that only plants differing in resource use are likely to coexist within plant communities, evidence related to the process of niche differentiation due to competition is almost absent. I studied divergence in resource-use traits in populations of two native annual species (*Impatiens noli-tangere* and *Galeopsis speciosa*) following invasion of the exotic invasive jewelweed *Impatiens parviflora*. In a common garden study, I demonstrated that *I. noli-tangere* from invaded populations germinated earlier than plants of non-invaded conspecific populations and an exotic congener. Invasion experience in *I. noli-tangere* also led to increased phenotypic plasticity, as shown by the greater production of root biomass under less shading and higher nutrient levels. Moreover, invaded populations were characterized by an improved shade-avoidance syndrome, as indicated by taller seedling height and capacity to maintain height in a resource-poor and more shaded environment. No post-invasion trait changes were detected in the less-related species *G. speciosa*. These findings are among the very rare results demonstrating resource-use trait differentiation in response to interspecific competition in plants. However, it remains to be demonstrated that these changes are adaptive through enhancing the probability of coexistence of native and exotic jewelweeds in invaded communities.

G1-P4: Does Himalayan Balsam have an allelopathic impact on its natural competitors?

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The invasive Himalayan Balsam (*Impatiens glandulifera)* is a very strong competitor, though it is an annual and has to establish over and over again. Some substances contained in the aerial plant parts are known to possibly affect germination of other species. We carried out laboratory experiments testing germination of common central European competitors (*Urtica dioica* and *Filipendula ulmaria*) in different solutions of *I. glandulifera* sap. Further on, germination of the same competitors was tested on soil material collected below *I. glandulifera* stands during different seasons of the year. Results indicate few negative effects on germination at high sap concentations, only. The relevance of this impact under natural conditions is discussed.

G1-P5: *Rubus armeniacus*: The triumph of an unidentified species and effects on ecosystem function

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"Bramble (*Rubus* sp.) covers vast areas" – such observations often lack further details concerning the species involved. In recent years, such statements often refer to *Rubus armeniacus*, which was introduced as a garden plant but spreads heavily in anthropogenic and seminatural ecosystems. How important is the invasion of *Rubus armeniacus*? How do ecosystems change, when invasion took place? Does the bramble build a kind of climax vegetation? Which are the successful dispersal strategies and limitations during establishment? During the last 2 years stands of *R. armeniacus* were studied in different regions in Rhineland Palatinate and in different habitats. The species has invaded ruderal sites as well as riverine areas, dry hillslopes at former vineyards and even dry calcareous grassland. We present first results on changing light conditions within the *R. armeniacus* stands, changes in plant diversity, organic layer, soil biological activity and observations on competition. Further on, seed stratification and seedling establishment experiments were carried out. First results of these experiments indicate especially strong seed dormancy, medium to high germination success and powerful seedlings which manage to survive even under very dark or dry conditions.

G1-P6: Invasion by *Acacia longifolia* alters pine forest water balance and carbon gain

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In water limited ecosystems, where potential evapotranspiration exceeds precipitation, it is often assumed that plant invasions will not increase total ecosystem water use, since all available water is evaporated or transpired regardless of vegetation type. However, invasion by exotic species, with high water use rates, may potentially alter ecosystem water balance by reducing water available to native species, which may in turn impact carbon assimilation and productivity of co-occurring species. Here, we document the impact of invasion by an understory exotic woody species (*Acacia longifolia*) in a semi-arid Mediterranean dune Pine forest. To quantify the effects of this understory leguminous tree on the water use and carbon fixation rates of *Pinus pinaster* we compare an invaded and a non-invaded stand. *A. longifolia* significantly altered forest structure by increasing plant density and leaf area index in the mid-stratum of the invaded forest. *A. longifolia* contributed significantly to transpiration in the

invaded forest (up to 42%) resulting in a slight increase in stand transpiration in the invaded relative to non-invaded forest. More importantly, both water use and carbon assimilation rates of *P. pinaster* were significantly reduced in the invaded relative to non-invaded stand. Therefore this study shows that exotic plant invasions can have significant impacts on hydrological and carbon cycling even in water-limited semi-arid ecosystems through a repartitioning of water resources between the native and invasive species.

G1-P7: Predicting interaction processes of native and invasive Salicaceae

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Willows of the *Salix alba–Salix fragilis* complex, *Salix babylonica* and its hybrids as well as some *Populus* taxa, native to Europe or Asia, are typical invaders of riparian floodplain ecosystems in Patagonia. Introduced to South America by European settlers, their distribution area has increased significantly along north-Patagonian rivers. These processes may have impacts on *Salix humboldtiana*, the only native woody species in this region. In this study, we will develop habitat distribution models for different life stages of native and invasive Salicaceae and two other important woody invaders (*Eleagnus angustifolia* and *Tamarix ramosissima*) including numerous abiotic factors e.g. elevation, flood duration, soil texture, location, island morphology and land use intensity. Data on species (presence/ absence, age class, abundance, dbh) and explanatory variables were gathered using a grid-based, stratified-randomized sampling design. The plots are located on islands of the upper and middle part of the Río Negro characterized by varying land use intensities. The investigations aim to identify ecological niches and niche overlaps among the life stages of the different species, to assess the competition potential and to predict further vegetation dynamics.

G1-P8: The invasive moss *Campylopus introflexus* alters functional diversity of ground dwelling arthropods

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Invasive alien plants can modify terrestrial habitats due to their impacts on plant diversity, vegetation composition, nutrient cycles and soil and microclimate conditions. Consequently, strong impacts on the natural faunal composition are to be expected. Despite effects on abiotic conditions and taxonomical components, invasions of alien species might have an effect on functional diversity for example by changing the compositions of functional groups or of life-history traits. In this study we aimed at analysing the impact of the invasive moss *Campylopus*

introflexus on the functional diversity of spiders and carabids by comparing pitfall trap data of invaded and native, lichen-rich grey dunes at the Baltic Sea. We observed (a) shifts in the proportion of life-history trait categories between the assemblages (e.g. more small species in native sites), (b) a more homogeneous trait composition in native sites, and (c) oppositional changes in functional diversity (expressed as functional dispersion): While functional diversity of spiders was higher in sites with a high cover of the invasive moss, functional diversity of carabids was higher in native grey dunes. We assume that spider assemblages of native sites contain many species with similar traits and a high redundancy. Species of carabid beetle assemblages of native grey dunes were more dispersed in functional traits and showed low redundancy. Our results suggest that (even) small-scale invasions of alien species might have strong – and opposing – impacts on life-history trait and functional diversity patterns of the native fauna and therefore on ecosystem functions.

G1-P9: Invasion of *Mediopyxis helysia* into the Wadden Sea

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The introduction of non-indigenous species has gained greater attention within the last few decades. In oceanic habitats, human mediated dispersal (e.g. ship´s ballast water or aquafarming) increases the possibility of invasions. Among other ecosystems, changes caused by invasion especially affect the complex and fragile ecosystem of the Wadden Sea, resulting in a significant rate of species extinction. These extinctions in turn favour non-indigenous species to invade and establish. Kühn et al. (2006) described the invasive diatom *Mediopyxis helysia*, which was first found in the German Bight at Sylt. Here, we present data of two consecutive years. In the first year, 2009, *M. helysia* occurred in the backbarrier tidal flat of Spiekeroog and dominated the phytoplankton community throughout the year. It also showed high abundances in 2010. Additionally, we conducted a laboratory experiment over four weeks, investigating under which nutrient conditions *M. helysia* performs best.

G1-P10: The impact of invasive Dreissenidae on the Aquatic Food Web

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Invasive Dreissenid mussels, (Bivalvia, Dreissenidae), like the Zebra mussel (*Dreissena polymorpha)* and the Quagga mussel (*D. rostriformis bugensis*), are among the most important invasive species. Due to their mass reproduction, dreissenids can have deep impacts on aquatic ecosystems. Studies from the United States indicate that recently a dramatic extension of the invaders is taking place. First studies from Western Europe seem to confirm similar developments. We are investigating the ecological factors which are responsible for the displacement and the successful invasion of the Dreissenids in Western Europe and discuss their impacts on ecosystem functions. Finally, implications for management and conservation are discussed.

G1-P11: Study type matters for detecting phenotypic differentiation between native and invasive populations – A meta-analysis on common environment studies

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In search of general explanations for increased invasive vigor, a multitude of common environment experiments have been designed to test for genetically based differentiations between native and invasive provenances of study species. However, their results are inconsistent if outcomes are summarized by vote-counting procedures. To detect overall effects, we investigated the results of 37 common environment experiments including 25 invasive species by means of a meta-analysis. Additionally, we tried to detect influences of study designs, i.e. greenhouse vs. common garden experiments, on the outcome of studies with invasive and native plant populations. Standardized effect sizes were calculated for the response variables size, aboveground, belowground and total biomass in each study and treatment therein. Afterwards, the grand mean overall studies and mean effect sizes for greenhouse and common garden experiments were separately determined for each trait.
The results confirmed the previous findings of increased growth of invasive populations. However, for individual plant height and aboveground biomass, this was only clearly detectable in common garden but not in greenhouse situations. The present findings suggest careful interpretation of single study results, given that uncovering differentiation between native and invasive populations strongly depends on the study designs and on the variables considered.

G2 Vector Ecology

Oral Presentations

G2-O1: Surveillance and control of mosquitoes (Culicidae) with special emphasis on climate change and risk of mosquito-borne diseases in Germany

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Surveillance of mosquitoes has to be one of the crucial elements in any comprehensive mosquito control programme. The German Mosquito Control Association (KABS) has been conducting surveillance programmes by means of adult mosquito trapping and larval collections since almost 3 decades in many parts of Germany such as the Upper Rhine Valley, along the rivers Danube, Isar, Elbe and Oder, lakes Chiemsee and Constance in order to assess the mosquito abundance and phenology as a basis for sound biological control operations based on *Bacillus thuringiensis israelensis* and *B. sphaericus*. Up to date a total of 48 established species have been recorded for Germany (47 autochthonous species and one alien species, namely *Aedes j. japonicus*) as well as *Aedes albopictus* (*Stegomyia albopicta*) as a non-established species. From the autochthonous species, *Ae. vexans* is by far the most abundant species in the floodplains of the Rhine Valley, lake Constance and the Elbe river plains, whereas *Ochlerotatus sticticus* is the dominant species along the lake Chiemsee and Easter-Lakes. All areas show a rich mosquito fauna.

G2-O2: Climate Change and globalisation as drivers of invasive aedine disease vectors

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Invasive mosquitoes such as *Aedes albopictus* and *Aedes japonicus* received much attention due to the possible expansion of new vector-borne infectious diseases to Europe. *Ae. albopictus* is in a rapid extension of its dispersal area: originally native in South-East Asia, it became a “global player” during the last decades and is now widely established in Southern Europe. This potential vector of various infectious diseases (e.g. Chikungunya, Dengue and West-Nile) is listed as one of the 100 “Worlds Worst Invaders”. Moreover, *Ae. japonicus* was recently found in Germany and Switzerland.
Especially the interplay between climate change and globalisation is of outmost interest for the introduction and establishment of these disease vectors. Whereas introduction and spread of vector species is mostly supported by human activities such as trade and traffic, colonization and establishment with successful reproduction is mainly dependent on suitable environmental conditions affected by climate change. Of further interest are the pathogens, which may be imported by infected travellers coming from endemic areas. A growing number of dengue

cases have been reported at higher latitudes, for instance, as a consequence of increased international travel and intensified and frequent outbreaks around the world.
Here we modelled a bioclimatic envelope of *Ae. albopicuts* and connected the results to future climatic conditions in Europe using regional climate change projections. Furthermore, the major thermal constraints of dengue virus are estimated and transferred to the expected future climatic conditions. These results are combined with possible dispersal mechanisms of vector and pathogen: introduction pathways such as harbours, airports and highways. Combining climate projections for vector and pathogen and their dispersal mechanisms may contribute to the identification of risk areas.

G2-O3: Some considerations for successful monitoring of Sindbis activity in mosquitoes

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Montioring and surveillance of arboviruses in the vector mosquitoes is not an easy task based on the complex population dynamics and different abundances of the mosquito species of interest. Thus the success of such a study greatly depends on previously known aspects and their consideration in the study design. We have performed a four year (2000-2003) study in the Dalälven flood plains in central Sweden in order to see whether or not the predicted seven year cycle of Sindbis virus (SINV) peak activity would return in 2002. In the first year 107,818 mosquitoes of 23 species were identified, pooled and tested for SINV in cell culture. One SINV isolate was obtained from 43 *Aedes cinereus* trapped September 19, 2000. Subsequent virus testing was focussed on four mosquito species. In total 21 strains of SINV (1 in 2001, 16 in 2002 and 4 in 2003, corresponding to an average prevalence of 0,4‰) were obtained. By dividing the species into generalists and bird feeding mosquitoes, the probability to detect SINV was higher in the first group containing *Ae. cinereus* and *Ae. rossicus* in 2002 and 2003. The probability to detect SINV among bird feeding mosquitoes did not correlate with the abundance of bird feeding mosquitoes, whereas the probability to detect SINV among generalist feeding mosquitoes was negatively correlated with their abundance. For *Culiseta morsitans* there was no association between its abundance and number of infected individuals or the probability to be infected. Nucleotide sequence analysis of about 2.000 bases revealed many nucleotide changes but no correlation between trapping site, year, or mosquito species SINV had been isolated from. One important finding was that the earliest SINV isolate of the season was from July 30, thus investigations of mosquitoes trapped earlier during the year are very unlikely to yield virus. Although the anticipated peak of SINV infections in humans was not observed in 2002, our findings show that the virus was most abundant in the mosquitoes that year, but obviously has not found its way to humans.

G2-O4: Mosquito colonisation in response to predatory taxa and abiotic factors

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Several predacious macroinvertebrate species could effectively regulate the populations of mosquitoes. We surveyed 164 temporary pools in a salt marsh system in order to study whether predators or environmental parameter may affect the mosquito fauna in brackish water bodies.

The taxa richness and the total number of predacious taxa both were positively correlated with habitat duration, surface area, and maximal depth of the pools, but no significant correlation was evident in respect of salinity.

The mosquito species *Ochlerotatus detritus* was the most frequent and abundant taxon, present in 96.3 % of the pools and accounting for 86.0 % of total faunal abundance. Analyses of predatory taxa demonstrated no correlation to the density of *O. detritus*, while highest explanatory power for culicid density were found for the variables habitat duration, surface area, and maximum water depth. Mosquito density increased with increasing habitat duration, but decreased with increasing area. *O. detritus* colonisation was highest at intermediate water depth. Again, salinity had no significant influence on the colonisation patterns.

G2-O5: Effects of forest composition and structure on Lyme disease risk

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The sheep tick, *Ixodes ricinus*, is a tick of considerable significance as vector of both livestock and human diseases. In Europe, this tick is the primary vector of Lyme disease, a serious illness caused by the bacterium *Borrelia burgdorferi*, which has emerged as a major public health problem. Because the tick is vulnerable to extremes of temperature and humidity, forests generally support higher tick densities than non-forested habitats. However, high variability in tick abundance is observed when comparing different forest types. Considering the threat of this tick to human health, it is important to better understand the main factors regulating tick abundance for the identification of high-risk areas. Fieldwork was conducted in the Campine ecoregion in Belgium. The forests are characterized by secondary pine plantations — mainly Scots pine — on nutrient poor and acid sandy soils, interspersed with deciduous stands of oak, beech, poplar and birch. The first part of this study was carried out in 21 forests. In each forest site, 5 to 15 pine- or oak-dominated stands (176 in total) were selected for a single sampling session. The second part was carried out in 2 forests, where ticks were collected periodically from 2008 to 2010 in 4 distinct forest stand types: oak and pine stands, both with and without substantial shrub cover. Ticks were sampled from the vegetation by drag sampling. Abundance of larvae, nymphs and adults was significantly higher in oak stands compared to pine stands. In addition, tick abundance increased significantly with increasing shrub cover. Thus, both forest composition and vertical structure are important indicators of favourable conditions for tick occurrence. This insight is especially relevant in the Campine region, where forest conversion (i.e. change in the dominant tree species from coniferous to deciduous and increase in forest structure) will take place over the next decennia.

H1 Linking Ecology and Ecotoxicology - examples, concepts and methodologies

Oral Presentations

H1-O1: Competition matters: Modelling population recovery after disturbance by toxicants

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Anthropogenic disturbances are an important driver of species occurrence and community composition. One of such disturbances is the exposure of ecosystems to agricultural pesticides, which can have profound negative effects on biodiversity. The question arises what processes have to be taken into account to assess the viability and recovery potential of populations and communities against pesticide exposure correctly.

Toxic substances can have acute effects on species (e.g. instantaneous death of individuals) or chronic ones (e.g. a reduction of the reproduction). Furthermore, the effects can act directly on individuals or indirectly through species interactions. Here we present a generic, individual-based model (IBM) composed of two interacting species to shed light on the role of competition. We investigate how lethal and sub-lethal, acute and chronic effects of toxicants are translated to population and community level response.

Interspecific competition can more than double the time it takes a population to recover to pre-contamination conditions. Furthermore, slight chronic effects in addition to acute mortality can have a substantial influence in population recovery. We also show how modelling results can be linked back to population pattern observed in an experiment with interacting Daphniidae species in experimental ponds. In conclusion, biological interactions as well as the life cycle parameters that are affected by the specific toxicant should be taken into account in pesticide risk assessment.

This presentation will also give a brief introduction to the session and wrap up why it is still timely to call for more ecology in ecotoxicology.

H1-O2: Species, speciation and environment - risk of silver nanoparticles

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Over the past decade, the market with products containing silver nanoparticles (AgNP) has exponentially increased. The particles can, e.g., be found in cosmetics, food packages, cleaning rags or sport textiles, with an accordingly high potential for release to the environment. Due to the microbicidal action of silver, recently strong concern has been raised that increasing amounts of nano-silver might have detrimental effects to the environment. We studied the effects of AgNP on algae, bacteria and crustaceans in comparison to silver nitrate. In addition, we modelled the speciation of silver with respect to varying environmental conditions.

At first sight, silver nitrate appears to be one order of magnitude more toxic than AgNP, yet at least in bacteria this effect may be reversed with increasing exposure time. Model calculations of chemical speciation showed that within the concentration range where the toxicity of AgNP to algae increased the concentration of silver ions should remain constant. Since the ions are thought to be predominantly responsible for the toxic action of AgNP, next to particle-specific effects two explanations are reasonable: a) due to organism uptake of Ag^+ the reaction kinetics are not in equilibrium, i.e. new ions are released as soon as those in solution have been taken up; b) other Ag species such as precipitated Ag^+ or $AgCl_{aq}$ exert toxic effects as well (or are converted to Ag^+ ions within the organism). $AgCl_{aq}$ has been shown to be the main bioavailable Ag fraction to other algae – however, not to fish. Also within algae, the sensitivity of different species to AgNP is highly variable – and the speciation of Ag strongly depends on environmental conditions such as salinity or pH. We conclude that a thorough understanding of both chemical processes and biological traits is necessary for assessing the environmental risk of AgNP.

H1-O3: Exposure to anticoagulant rodenticides and residues in non-target species

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Anticoagulant rodenticides (ARs) are widely used for rodent control. Because of the delayed impact - due to their anticoagulant character - there is a potential risk for predators to ingest poisoned rodents (secondary poisoning). Studies from other countries (e.g. U.K. and New Zealand) indicate that rodenticide active agents are transferred through the food chain. Nevertheless, regional conditions, farming practice and areas of rodenticide use differ between countries. Data on AR-residues in non-target species in Germany is scarce and no systematic research on exposure paths of AR has been conducted so far. Hence, the aim of our study is to test if there are correlations between the concentrations of ARs in target species, non-target rodents (primary poisoning) and owl pellets.

Experiments are carried out on farms close to Muenster (North-Rhine Westphalia, Germany) to investigate this question. Rat snap traps are placed where rat trails have been found or at places with potential rat occurrence. Mice snap traps are set in two transects extending from the farm to define the distance of poison distribution within non-target rodents. In the same period, owl pellets of barn owls (*Tyto alba*) and little owls (*Athene noctua*) are collected. Fresh pellets and liver samples of rats and mice will be analyzed in terms of residues of eight ARs (Brodifacoum, Bromadiolone, Chlorophacinone, Coumatetralyl, Difenacoum, Difethialone, Floucomafen and Warfarin) by using HPLC. Pellets are also used to analyze the food diet of the owls. Food composition and AR-residues in pellets, target and non-target rodents will be used to assess the potential local risk for the two owl species to ingest poisoned prey.

First data of our fieldwork will be presented. An overview of further work including records of AR-residues in predators found dead in Germany will be given. (This study is funded by the German Federal Environment Agency grant number 3710 63 401.)

H1-O4: Combining population models with spatio-temporal pesticide exposure patterns

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This presentation shows first results from investigations about if and how effects of chemical stressors on populations and the population recovery differs between local and regional (i.e. larger scale) model simulations. We will analyse how characteristics of the chemical stressors, the landscape and the species influence the recovery of affected species at the regional scale. We will also show how to develop appropriate indicators addressing the risk of chemical stressors at a regional scale.

Specific hypotheses to be tested are

- Would local reproduction or different modes of dispersal (walking, swimming, drift, aerial) determine recovery on a regional scale after disturbance?
- How do different chemical fate properties and herewith exposure patterns relate to the effects and the recovery from effects?
- How do differences in landscape infrastructure (ecological connectivity) influence the recovery at the regional scale?
- Which species, landscape and chemical traits are appropriate ecological, infrastructural and stressor indicators for risks and effects of pesticides on a regional scale?

Chemical fate simulations in stream, ditch or river networks are used as exposure pattern in effects simulations with NetLogo/MASTEP models for *Asellus aquaticus*. Special consideration will be paid on the chemical side to the influence of pesticide properties on the magnitude and duration of effects, and on the biological side on the influence of species traits and landscape properties on effects and recovery.

The presentation shows an approach to extrapolate chemical effects from a laboratory scale to real-world scales in terms of agricultural landscapes. The used methodology will ensure to identify decisive factors for possible chemical risks, e.g. chemical persistence or toxicity, time point of application, river network properties, species traits, and so will be useful for risk mitigation strategies.

I1 Drivers of differentiation and homogenisation of urban biodiversity

Oral Presentations

I1-O1: Plant species distribution in Hamburg - drivers and patterns

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Diverse and highly dynamic habitats, variable anthropogenic disturbances and favourable climatic conditions lead to high plant species diversity in cities. Species distribution is affected by various environmental conditions, e.g. settlement structure, land-use and climate. In Hamburg, the urban heat island effect leads to an increase in mean temperature by 1 K along the urbanization gradient towards the city centre (Schluenzen et al. 2010) and climate change is also expected to have an influence on plant species distribution in future. Ecosystems in Hamburg are very diverse, including urban areas like the port and main settlement areas as well as cultivated landscapes, nature reserves with forests, peatlands and habitats along the river Elbe.

We are analysing a floristic database of Hamburg mapped on a 1 km² grid scale (Poppendieck et al. 2010) to identify the underlying factors of plant species distribution and evaluate possible future trends regarding climate change. The spontaneous flora of Hamburg consists of about 1200 vascular plant species. Species richness per grid cell increases with increasing habitat diversity. Harbour and industrial areas in the centre are particularly species rich. Species and species communities distribution show distinct patterns and can be related to urban structure variables as well as to climate and land-use. Species traits distributions (e.g. life cycle, life form, floristic status) are also influenced by the respective variables. Alien and thermophilic plants occur mainly in the city centre and are positively correlated with mean annual temperature.

I1-O2: Homogenization in the urban matrix: comparing floristic diversity.

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The relative contribution of plant invasions and urbanization on the homogenization of urban floras have rarely been assessed at the plot level. We here use a frequent nonnative tree species of urban environments, *Robinia pseudoacacia*, as a model species to reveal the processes that lead to homogenization at the local scale. *Robinia pseudoacacia* is known for its homogenizing effects on understorey vegetation due to nitrogen accumulation by the root system. As a pioneer species in urban wastelands, *Robinia* is also a dominant tree in many wild urban woodlands. We hypothesize that both the surrounding urban matrix and the invasion by *Robinia* exert homogenizing effects on urban woodland patches.

We assess the joint effects of *Robinia* invasion and urbanization at the plot level by comparing the understorey vegetation of *Robinia* stands to nearby *Betula pendula* stands of similar age and comparable site conditions. Plots were stratified by 3 urbanity classes that were derived from the proportion of paved area in the vicinity of the plots.

Besides a marked decline in species richness compared to *Betula* stands, we did not observe a homogenizing effect of *Robinia* on the entire species pool. When separating native and nonnative understorey species, we found a significant decline in betadiversity for nonnative species but not for natives in the *Robinia* stands. This effect was independent of urbanity. Homogenization was significantly higher in the intermediate urbanity class compared to both high and low urbanity classes. This effect was independent from *Robinia* invasion.

We conclude that *Robinia* invasion and urbanity have different effects on homogenization. High homogenization under intermediate urban influence may result from a higher connectivity of wild urban woodlands in this area that could promote species exchange between the patches. The strong decline of species richness in *Robinia*-stands probably promotes homogenization at larger spatial scales.

I1-O3: Species diversity and plant trait variation along a spatio-temporal urbanization gradient in oligotrophic grassland

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Ongoing urbanization is one of the key processes of global change. In our study, we investigated its effects on the vegetation of oligotrophic grassland which once was the most common habitat type in the north of Munich. There, we established a transect which represents a spatio-temporal urbanization gradient from traditionally used calcareous grassland to traffic or industrial habitats shaped by typical urban usage. At 15 research sites with 8 sampling quadrats each, the species composition, species traits and 16 environmental variables were recorded.

A PCA revealed that former soil disturbance and paving explain a higher proportion of the environmental variation along the urban-rural gradient than the distance to the town centre. RQL analyses and fourth-corner statistics were used to link species traits to environmental variables. The results indicate that sites with an intense soil disturbance and a long urbanization history favour short lived ruderal species with insect pollination and dysochorous dispersal. In contrast, typical species of calcareous grassland and those with effective vegetative and ant dispersal were reduced. Seed traits (longevity, mass and shape) did not significantly change along the disturbance gradient.

The ancient grassland harboured a higher species diversity, higher numbers of threatened species and lower percentages of non-native plants than the disturbed sites. Thus, our results on oligotrophic grassland are consistent with those describing urbanization gradients in natural ecosystems like woodlands or wetlands. However, since rare species naturally growing on rocks or open sand additionally colonized some of the urban plots, urbanization decreased the area and species diversity of traditionally used oligotrophic grassland but increased the overall number of threatened species.

I1-O4: What causes local homogenisation in birds along an urban gradient?

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We analysed the effect of the urban matrix, which is the space surrounding distinct habitat patches, on bird communities. Therefore, we used a set of 54 wasteland sites of early successional stages that were scattered over the entire urban area of Berlin, Germany. Sites were similar to each other in habitat structure but differed in their surroundings, the urban matrix. Thus, they serve as a quasi-experimental setting to study associations between birds and the urban matrix. Our measure for urbanisation is human population density and degree of sealing within 50 m to 2000 m buffer zones surrounding each wasteland site. Along the urbanisation gradients we calculated alpha diversity and beta diversity (by applying a moving window method), and frequencies of several species-specific ecological characteristics.

Alpha diversity did not change significantly along the gradients of urbanisation. However, beta diversity increased along the urbanisation gradients with urbanisation at the local scale (50 m) but decreased at the landscape scale (200 m and 2000 m) indicating a local homogenisation effect. Analysis of relationships between the degree of urbanisation and ecological characteristics showed shifts along the urban gradient: adult survival rate increased with human population density, densities of birds that are more often reported to show innovative behaviour increased with both human population density and degree of sealing; in other word: highly urban-adapted birds are long-living and clever. We conclude that the influence of the urban matrix contributes to the homogenisation of the avifauna by filtering certain ecological characteristics and promote others.

I1-O5: Introgression of ornamental genotypes in native populations of an evergreen tree

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Biological invasions are common in urban environments, but the escape of ornamental plants within the native range of conspecifics is an overlooked component of this process. The present study is filling this gap by investigating naturalization and genetic introgression of ornamental *Ilex aquifolium* in Denmark.

Nursery catalogues were used for tracing the introduction history of this potentially invasive species and for quantifying changes in propagule pressure (1841–2007). In addition, 187 individuals of natural, naturalized and cultivated *I. aquifolium* were sampled throughout Denmark and compared using microsatellites and AFLP. Dispersal limitation was tested with fruits of native *I. aquifolium* and three cultivars offered to birds. We also conducted a transplant experiment to study possible negative effects of a monophagous leaf-miner (*Phytomyza ilicis*).

The number of nurseries per area was higher in eastern Denmark, outside the natural range of the species, while the proportion of frost-hardy cultivars increased in parallel with milder winters. The molecular markers revealed no structure of historical and expanding populations, or of natural and cultivated samples. The four fruit types were removed at different rates and red fruits of cultivars were preferred to native *I. aquifolium*. The leaf miner was present in the entire range of *I. aquifolium* in Denmark, but the native provenances supported higher densities than the cultivars.

We conclude that nurseries play a significant role in increasing the propagule pressure of potentially invasive *I. aquifolium*, leading to frequent hybridization between natural and cultivated genotypes. This process is facilitated by bird dispersal, while there was little evidence that release from a specific herbivore is involved in the current invasion and range expansion of the species in northwestern Europe.

I1-O6: Trap-nesting insects' interactions in an urban-rural gradient

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Increasing urbanization is known to cause serious decreases in wildlife species richness. The effects of habitat loss have been studied using mobile insects because of their high species number, their use of multiple habitats and responses to environmental quality and quantity of available resources. In this study we have chosen some of the major groups of insects that play a role for the maintenance of ecosystem functioning, such as predators, parasitoids, and pollinators. We investigated the diversity and abundance of trap-nesting bees, wasps and their natural enemies from urban to agricultural land around the city of Lüneburg, Germany. We expect that gardens surrounding the city adjacent to rape fields and rape fields adjacent to urban gardens have higher species diversity than rape fields isolated from urban areas or city gardens. We exposed standardized trap nests for bees, wasps and their natural enemies in 20 sites comprising four habitat categories in a gradient from the city centre to rape fields isolated from the city, from April to October 2010. The preliminary results show that the sampled gardens surrounding the city adjacent to rape fields have the highest species diversity, number of brood cells, as well as a high rate of parasitism. However, the rate of parasitism for wasps, but not for bees, was higher in gardens in the centre of the city. Our preliminary results, although highlighting the importance of gardens and green spaces in urban areas for insects interactions, do not yet support the idea of higher insect species diversity and interactions in rape fields adjacent to gardens.

I1-O7: A city park as a biodiversity hotspot: free-living species in Basel Zoo

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Urban environments are often characterized as supporting a few abundant, generalist plant and animal species well adapted to live alongside humans. City parks, however, may harbour a much higher species richness than previously assumed. So far, there are surprisingly few biodiversity surveys in city parks. Using an all-taxa-biodiversity-inventory approach, a team of 46 zoologists and botanists carried out a three-year study to assess the free-living organisms (plants, fungi, animals) occurring in the areas between the zoo animals' enclosures in Basel Zoo. This city park measures 11,6 ha and is surrounded by buildings und urban constructions except over a short distance towards the river Birs. A total of 3110 free-living species could be documented in this relatively small city zoo. However, not all taxonomical groups could be considered, mainly due to the lack of experts. It was estimated that the actual richness of free-living species in Basel Zoo may exceed 5500. Thus, the number of free-living species is approximately 8 to 10 times higher than the 646 species of zoo animals. The findings are important for preserving both the valuable remnants of natural and semi-natural habitats and threatened free-living species in the city park. The project combines research and outreach, which can improve the understanding of native biodiversity in urban areas while simultaneously raising the awareness of the threats to it. The success of sustainable garden management in protecting native biodiversity may motivate the public for own "wildlife-friendly" gardening activities.

I1-O8: Growing city, growing diversity? Public-park vegetation in Santiago de Chile

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Santiago de Chile, directly situated in one of the world's biodiversity hotspots, is becoming a megacity. Thus, urban green areas are retreats not only for human inhabitants but gain increasing importance for plant species. Especially urban parks may host remnants of former native plant assemblages as well as exotic ornamentals and contribute to biotic differences.

We studied the spontaneous vegetation of Santiago's urban public parks in two habitat types, grasslands and tree plantations. Abundance, regeneration and origin of species in 150 plots were compared along an urban-rural gradient, which depends on residential density. With Nonmetric Multidimensional Scaling (NMDS) we related species data to further environmental variables some of which describe direct human influences, e.g., recreational pressure or maintenance intensity.

In grassland habitats, species richness was highest in the inner city and at the growing city's fringe, with high proportions of exotic species in all residential density classes. In tree plantations, exotic species prevailed in all residential density classes also, but total species richness increased from the city's fringe to the inner city. In both habitat types, park maintenance was a major influential variable describing species assemblages, independently from the surrounding residential density.

As one of the first studies on urban biodiversity in South America, our results confirm insights about European or North American urban park vegetation but also identify differences. The combination of vegetation data with direct human influences allows recommendations for urban green planning.

I1-O9: Perception of nature conservation goals in historical urban parks by local actors

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Garden heritage conservation is not always in line with nature conservation goals. However, the function of historical gardens as preserves for endangered species often relies on the long lasting maintenance of the garden elements. A mutual communication between local actors about the goals and requirements of both heritage conservation and nature conservation could help to preserve biodiversity during regular park maintenance.

To assess whether deficient acceptance and knowledge of nature conservation objectives hampers their implementation in garden heritage maintenance, we conducted an online interview among 94 local actors involved in the preservation of garden monuments in Berlin.

The aim of the study was to reveal congruency and differences in the perception and acceptance of nature conservation goals between local actors from garden heritage conservation and nature conservation.

The results show fields of common sense as well as items of controversial debate. A wide acceptance among all professionals was revealed for the preservation of old dying trees and of species-rich meadows. Divergent goals of heritage conservation and nature conservation became apparent when more practical questions were raised. Among professionals involved in heritage conservation, a low acceptance was revealed for the preservation of dead trees with a polled crown and for leaving dead wood visible on the ground. On the contrary, professionals involved in nature conservation showed low acceptance for cutting free visual axes that belong to the historical garden design, and for reconstructing historical walkways within areas of high biodiversity.

Our results point out subjects that demand for increased coordination between the different actors involved in the conservation of historical garden monuments. We also identify recurring conflicts that could easily be resolved by improved information on biodiversity values for local gardeners.

Poster Presentations

I1-P1: Dispersal limitation in Central European urban communities

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It is generally believed that communities of small organisms or those with small propagules are structured mainly by local niche-based processes and less (or not at all) by dispersal limitation. Conversely, weaker environmental and stronger spatial structure, indicating dispersal limitation, is expected to occur in communities of large organisms. However, spatial and environmental effects have been rarely compared across groups of organisms of different body and propagule size sampled at the same set of sites.

We compared spatial effects with the effects of climate on species composition of (a) subaerial cyanobacteria and algae, (b) vascular plants, (c) land snails, and subgroups of plants with different life form and dispersal mode (d) herbs, (e) animal dispersed and (f) wind dispersed trees and shrubs each of them consistently sampled in 32 cities of Central Europe, Belgium and the Netherland. Data were analysed by variation partitioning based on the redundancy analysis (RDA) with principal coordinates of neighbour matrices (PCNM). Eighteen spatial PCNM axes and three macroclimatic variables were used as explanatory variables.

It was found that beta diversity of cyanobacteria/algae was lowest and that of snails highest among the cities. Still the community of cyanobacteria/algae possessed much stronger spatial structure independent of climate than communities of the two groups of larger organisms. We hypothesize that the community of cyanobacteria/algae is structured by natural dispersal processes which involve dispersal limitation, whereas spatial structure of plant and snail communities is interfered due to human-assisted dispersal among cities. Communities of wind and animal dispersed trees and shrubs are more structured by dispersal processes than communities of herbs.

We conclude that communities of small organisms can exhibit distinct spatial structure even though most of them have large geographical ranges.

I1-P2: Composition of vascular plants community in public green areas of Valdivia, Chile

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Land use change has been recognized as one of the main factors of biodiversity loss at global scale. An important type of land use change is urbanization. More than 70% of the world population lives in cities and the tendency is continued growth especially in developing countries, in which urban studies are scarce. Concentration of trade activities and traffic in cities as well as socioeconomic factors are known to be relevant in the intentional and unintentional changes in the composition of the flora and fauna of cities. In the last years several studies showed that these changes can create novel community assemblages and affect species interactions. Those changes in plant composition may have an effect on ecosystem functioning which can be assessed by the use of functional traits. In this work we will show the first results of the taxonomic and functional composition of vascular plant community of public green areas of Valdivia, Chile, as an example of a city of a developing country. We considered the relation of vegetation with abiotic (soil), social and economic factors to asses drivers of the distribution of spontaneous and planted vascular plant species across the city. We used four socioeconomic classes, defined by the governmental National Institute for Statistics of Chile, as the base of our plot selection, which resulted in 240 plots. We placed our plots in lawns as well as flower beds. We measured cover-abundance and traits only spontaneous but recorded the presence of planted species. Plant traits as plant height, leaf area and leaf weight, leaf dry matter content and specific leaf area were recorded following the LEDA standards of all but the rare species per plot. Preliminary analyses showed a high prevalence of plants with European origin on plots sampled across the city and the richness of spontaneous vascular plants in public green areas seems to correlate positively with the socioeconomic status of the neighbourhood.

J1 From Ecological Science to Ecological Application and Environmental Planning (D/ENG)

Poster Presentations

J1-P1: Analysis of farmers' land use decision-making with respect to ecosystem services

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The concept of ecosystem services appreciates natural systems not only for their productive functions, but also takes into account their support of human welfare by providing ecological and social benefits. The approach is increasingly recognised by individual and institutional stakeholders as it promotes environmental management that incorporates ecological concepts and economic objectives at the same time. Its practical implementation, however, is widely lacking and monetary motives still hold sway. With respect to agrarian landscapes, land use is the proximate link between farmers' decisions and the provision of ecosystem services as well as wildlife habitat. Thus, understanding farmers' land use decision-making is of key importance for environmental policy programs. We examined land use decisions of organic and conventional farmers cultivating rice, annual dryland crops or perennial crops in Haean watershed, South Korea. Our decision analysis considered their attitudes towards four ecosystem services: (a) biomass production, (b) soil erosion, (c) water quality and (d) biodiversity. We also explored the influence of social norms as well as perceived behavioural control factors on farmers' decisions. Results show that attitudes towards ecosystem services, social norms and control factors beyond monetary intentions have a significant influence on land use choice. Furthermore, these factors also lead to significant differences between organic and conventional farmers. By revealing these motives of paramount importance for agricultural land use decisions, our findings lay the basis for successfully designing and implementing environmental policy programs that aim at achieving more than economic objectives.

J1-P2: The role of wind turbines in the context of habitat quality – the case of Lapwing, Skylark and Meadow pipit in a cultivated raised bog in northern Germany

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Most scientific studies of the displacement effects on breeding birds do not take the habitat quality into account. Therefore they mostly assume that the distribution without wind turbines

is more or less uniform. In this way however, it is not possible to separate the effects of wind turbines from the influence of other parameters.
In a 2 year study we compared breeding densities of Lapwing, Meadow pipit and Skylark between 2 wind farms (1 in construction within the study time) and a reference site on the basis of areas with the same habitat quality. The habitat quality was calculated by using multiple logistic regression with data of the birds in the reference area. The habitat parameters included vegetation and structure parameters, land use, ground colour, etc. The habitat models led to maps representing the occurrence probability of the species in the whole study area. To define areas of good habitat quality a threshold value was calculated which gives the best prediction of presence and absence.
The results show that the density of the species in areas with good habitat quality is equal or even higher in the wind farms than in the reference area. The before-after comparison of the Lapwing breeding density showed a decrease within the overall wind farm area but an increase in the area of good habitat. This emphasizes that assessing the effects of wind turbines without taking the habitat quality into account might lead to wrong conclusions.

J1-P3 A multi-method approach to determine the impact of existing wind power plants on bird and bat migration on the island of Fehmarn, Germany

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The island of Fehmarn, situated off the German Baltic coast, is well-known for being a hotspot for bird migration. It is assumed that about 100 mio. Scandinavian birds cross the island each year. On the other hand there are already four major wind farms located on Fehmarn. Moreover, there are plans for more and higher wind power plants. To investigate the influence of the existing wind farms on bird (and bat) migration and to be able to assess the possible impact of future developments, a comprehensive research project was carried out in 2009. It comprised five subprojects using different methods:

- The number of migrating birds at different heights – especially at night – was determined with two vertical radar installations at different locations.
- Daytime bird migration was recorded simultaneously using six observers distributed over the island.
- Staging birds were mapped once a week covering Fehmarn almost totally to investigate the spatial distribution in relation to the wind farms.
- In the autumn period a systematic search for collision victims under 65 wind turbines was conducted and search efficiency and carcass removal by scavengers was estimated by experiments.
- Bat activity was registered with automatic ultrasound recording at hub height and ground level.

J1-P4: The influence of wind turbines and habitat structure on breeding parameters of the Ortolan (*Emberiza hortulana*)

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The breeding density of the Ortolan (*Emberiza hortulana*) has massively decreased in many parts of Germany since the 1960s. The species is listed on the Red List of endangered species in Germany and in the Appendix 1 of the Council Directive 79/409/EEC on the conservation of wild birds. With the progressive expansion of wind farms also in Ortolan habitats there was the need for a study of the effects of wind turbines on this species.
This poster shows the results of a study in 5 wind farms with adjacent reference areas in Lower Saxony, Saxony-Anhalt and Brandenburg. During 8 surveys every Ortolan observed was monitored for at least 2-3 hours to get notice of territory size, nest location and mating status. Beside these breeding parameters not only the distance to the next wind turbine was taken into account, but also habitat parameters like agricultural land use, tree species of the next song perch, etc. With several statistical methodologies like correlations, T-Tests and multiple logistic regression, we did not find any significant avoidance effects of males and couples. Nevertheless, the number of pairs in relation to unpaired males increased with growing distance to the next wind turbine. This was due to a surplus of unpaired males in the proximity of wind turbines. The analysis of habitat parameters shows that some of them have significantly more influence on the spatial distribution than the distance to the next wind turbine.

J1-P5: Exploration and production drilling in the EEZ - Minimizing impacts on benthos and harbor porpoises

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Since 1960s drilling work has been taking place in the North Sea. Using the example of the only permanent installed rig A6-A in the German North Sea (northeast of the EEZ on the Doggerbank) the poster shows the impact factors of drilling. The main focus is put on impacts on benthos and harbor porpoises and possibilities of minimizing the impacts. The poster describes which mitigation measures where used and which influences where still observed during the monitorings.

J2 Adaptive nature conservation under climate change: from science to practice

Oral Presentations

J2-O1: Climate-change-induced stresses of biodiversity and how to integrate them into adaptive conservation planning

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Conservation actions need to account for and be adapted to address changes that will occur under global climate change. The identification of stresses on biological diversity is of crucial importance for adaptive conservation management in order to identify conservation needs, build adequate, and proactive strategies and a robust monitoring system. Applying a systemic approach and a hierarchical framework we developed a comprehensive classification of stresses on different levels of biological diversity directly caused by global climate change. In our definition any impact of climate change on biological diversity is a stress whenever it represents a change (negative or positive) in key ecological attributes of an ecosystem or parts of it. We considered stresses on individual and population level, stresses on the level of the biological community and stresses on ecosystem level as well as changes of ecosystem services. In order to find out, how climate change is already integrated into conservation planning we analysed 103 management plans of conservation sites in North, Central and South America. We examine how climate change has already been taken into account in the various steps of adaptive management planning and what kind of different stresses have been documented by planning teams. The minority of conservation management plans consider climate change as a threat (25%), mostly regarding changes on community level, and only 8% integrate climate change into their strategy planning. Since climate change is rarely sufficiently integrated into conservation planning we propose to actively use the stress classification in the process of adaptive conservation planning. Our classification may be used to identify key climate-change-related stresses to biological diversity and may assist in the development of appropriate conservation strategies.

J2-O2: The vulnerability of mires in Brandenburg (Germany) to climate change – developing a vulnerability index

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The federal state of Brandenburg in NE-Germany still offers a high amount of mires in a wide hydro-ecological range. However, this region is significantly affected by climate change. Since mires are considerably vulnerable to changes in their water supply, it is widely accepted that changes of meteorological elements will have an increasing effect especially on mire hydrology. Of great interest is in how far the hydro-ecological condition of mires will be affected in upcoming decades.

We hypothesized that the future condition of mires strongly depends on several parameters (e. g. current hydro-ecological condition, landscape properties or status of landscape water budget). These parameters need to be considered differentiated in order to estimate possible effects of climate change to uncultivated mires in Brandenburg. For this purpose, we develop a vulnerability index. Vulnerability results from the interaction of any change in exposure (temperature and precipitation), particular sensitivity (= impact) as well as specific adaptive capacity. In order to determine the hydro-ecological characteristics of mires we use the Brandenburg mire-biotope mapping as basis of assessment. The index consists of various factors, each derived from attributes supposed to affect the vulnerability of mires to climate change. In order to quantify the specific degree of vulnerability, all factors are scored on a 5-point scale, from 1 (very low vulnerability) to 5 (very high vulnerability). Finally, the scores of all factors are combined. The index is exemplarily tested and verified in mires in the biosphere reserve Schorfheide-Chorin.

The aim of this vulnerability index is to enable priority setting for a proactive management of mires to counter ongoing losses of these specific ecosystems.

J2-O3: Genetic population structure of *Bombina bombina* - Implications for conservation

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Genetic diversity and population structure of amphibians are frequently influenced by habitat destruction, particularly in areas of dense human population and intensive agriculture. We report the genetic population structure of the fire-bellied toad *Bombina bombina* in Brandenburg (East Germany) in the context of conservation and management. We analysed 298 samples originating from 11 populations in Brandenburg using mitochondrial control region sequences and six polymorphic microsatellite loci. We detected a moderate variability in the mitochondrial control region (18 different haplotypes) and at microsatellite loci (9 to 12

Alleles per locus). These polymorphisms allowed us to discover a clear population structure among toads in Brandenburg. Despite of a relatively high overall population density a clear genetic divergence between the populations exists. The overall genetic population structure is in agreement with a postglacial colonization from South East-Europe and a subsequent population expansion. We show that the current habitat fragmentation in Brandenburg has not lead to similarly strong genetic divergence as in comparable areas, but it is likely to become an increasing threat for the survival of *Bombina bombina*. The documented constant decrease of population sizes and genetic exchange will inevitably lead to a loss of genetic variability, unless appropriate management measures are taken. These measurements should focus on specific ponds and hibernation sites where favourable conditions for toads should be maintained or - if necessary – reestablished by habitat restoration. It should be attempted to maintain self-sustaining populations to avoid the need of cost intensive and risky supportative breeding in the near future.

J2-O4: Changing water beetle communities and diversity - a 20 years comparison

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In a study on stagnant waters in 1991ff, Schmidl (2003) recorded the water beetle fauna and assemblages in the area of Erlangen-Höchstadt. Zoder (2009) studied successional aspects by resamplings, Ganz (2011) monitored a selection of ponds by bottle- and funnel- traps.

The fauna of big water beetle species (esp. Dytiscinae) shows two trends: 1) 20 years after the first sampling campaign, many typical “pond species” could not be re-collected; 2) *Cybister lateralimarginalis* (tropical-subtropical Cybisterini) has become dominant, whereas most *Dytiscus spp.* (nordic-temperate Dytiscini) have vanished (*D. latissimus*, *D., circumcinctus*) or become scarce (formerly abundant *D. marginalis*). In contrast, thermophilous *D. circumflexus* is now established abundantly in the ponds.

Intense pond management and loss of vegetation structure is a major threat to dytiscid species. But also in unmanaged old nature reserve ponds, several so far abundant, “nordic” *Dytiscus*, *Hydaticus* and *Graphoderus* spp. are missing now, obviously being competed out by thermophilous species, or on retreat by climatic reasons, or both. Dytiscid water beetle fauna is more diverse in nordic zones than in temperate and subtropical ones (Larson 1985), so rise in temperature will trigger a continuing change and loss of dytiscid fauna in Central Europe. Long-term sampling of water beetles seems to be a sensitive tool to monitor effects of climate change and changing pond use intensities.

J2-O5: Adapting regional administrative conservation to climate change - a Q&A guide

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Fundamental to any climate change-adaptive biodiversity strategy is the question which conservation goals are set. Science should take the responsibility of giving advice to society in finding the right answers. The German federal state of Brandenburg, due to, among others, relatively low precipitation and soils of poor water carrying capacity, is highly impacted by climate change and will probably be more so in the future. As elsewhere, its state administrations are key actors in the adaptation process. With laws lagging behind the general discourse, the research project “Adaptation of administrative nature conservation to climate change in Brandenburg” (in the framework of the “Innovation Network Climate Change Adaptation Brandenburg Berlin”) is designed to bridge the imminent gap between science and practice. In collaboration with governmental conservation decision-makers and further conservation actors, a guideline for the adaptation of the goals of nature conservation was developed. It aims at helping conservationists in successfully rethinking the alignment of goals to be climate change-adaptive. It avoids biocentric, purely evidence-based, linear cause-effect answers. Instead, it acknowledges the importance of handling complexity and non-knowledge. For the benefit of society, functionality of biodiversity is recommended to be a guiding priority. Reducing the vulnerability of biodiversity, which is in large part caused by mismanagement, is considered a key component of the strategy. While the document is founded on ‘state of the art’ scientific concepts, its general structure facilitates easy access through a scheme of questions and answers. A concluding synthesis provides a framework for a climate change-inclusive environmental strategy of Brandenburg State.

J2-O6: Priority setting for nature conservation under global climate change

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Despite intensive efforts, ongoing attempts in conservation have failed to halt biodiversity loss and ecosystem degradation. Under accelerating global climate change new strategies for nature conservation are urgently needed with a focus on protecting the most functional and intact ecosystems. A new approach of defining targets for proactive and adaptive nature conservation under global climate change is suggested. Global as well as regional composite indicators for the Federal State Brandenburg are proposed based on functional conservation

priority setting. By applying principles of ecosystem thermodynamics that focus conservation efforts on the most functional, diverse and resilient ecosystems, and through the utilisation of indicators for ecosystems´ structural complexity, information and biomass, an alternative strategy for conservation is constructed. Furthermore, social, economic as well as political parameters that have implications for nature conservation, and that also emphasize the importance of an interdisciplinary approach in conservation planning are applied. The findings of our research have important implications for nature conservation prioritization schemes focusing on ecosystem functionality and resilience. Particularly in the current situation of accelerating climate change and population growth approaches favouring ecosystems buffer and adaptive capacity are crucial for long-term sustaining of biodiversity and ecosystem services.

J2-O7: Increased intra-annual precipitation variability: how to conserve forage quality

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Greater intra-annual precipitation variability is predicted for many regions on earth, leading to longer dry periods and more intense rainfall events. Recent studies suggest that changed precipitation variability is altering grassland productivity but it remains unclear how forage quality is affected. Here, we present results from the field experiment EVENT II in which an extensively used Central European grassland was subjected to increased rainfall variability (low, mid and extreme rainfall variability without any change to the annual rainfall amount). We further asked if the application of fertilizer (NPK) and the delay of mowing are useful management options to buffer against loss of forage quantity and quality. Rainfall variability, fertilization and mowing were fully crossed and each factorial combination was replicated five times. We assessed biomass production and forage quality parameters such as crude protein, crude ash, crude fat and fibre, sugar content as well as neutral detergent fibre (NDF). Biomass production, NDF, crude fibre and sugar content decreased with increasing precipitation variability. Fertilizer application did not affect the response to increased variability. Delayed mowing buffered against the reduction of crude protein with increased variability, while biomass production was not affected. When extreme drought periods occurred later in the year, crude protein, sugar and biomass decreased even stronger while crude fibre and fat increased. These results may contribute to the discussion on adaptation against climate change in extensively used grasslands which are of high value both to agriculture and nature conservation.

J2-O8: Adaptive conservation planning: examples from Brandenburg, Germany

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Climate change and its related consequences force nature conservation to reconsider as well as redefine current planning and management tools. Conservationists have to test and apply new methods capable of adequately dealing with rapidly changing environmental conditions and the increase of uncertainties. Adaptive management, comprising the permanent evaluation of implemented measures and results as well as the redefinition of targets and strategies, is promising. In our research, we applied the Conservation Measures Partnership's Open Standards for the Practice of Conservation, a management tool which is based on the principles of adaptive management, to develop a climate change-adapted (I) district conservation plan (Barnim, Brandenburg, Germany) and a (II) protected area management plan within the same district. We amended the tool with some additional methodological steps in order to adequately include issues of climate change and legal requirements. Moreover, we analyzed how the nested application of the Open Standards on different spatial and administrative levels contributes to better coherence in target-setting and their spatial prioritization, as well as in aligning strategies through various institutional levels for increased efficiency and effectiveness of conservation measures. As a result, we find that the Open Standards pose a promising tool to bridge current planning and communication gaps.

J2-O9: Development of a holistic evaluation method for ecosystem services

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There are various approaches to classify and assess ecosystem services but a general and consistent evaluation method that can be applied under a broad range of conditions is still missing. This shortcoming impedes a systematic comparison of results of the numerous studies on ecosystem service assessment worldwide. As a consequence, the realised results remain case-specific and shortcomings are often difficult to detect. Here, we propose a 'holistic' approach to assess ecosystem services under Global Change that can be applied independently from specific system features and that allows to compare results across system boundaries.

Based on the approach by Boyd and Banzhaf (2007), we developed a methodological framework, which includes (1) the identification of the individual demand from stakeholders, (2) the identification of the potential of the examined ecosystem type to provide ecosystem services, (3) the classification of specific final ecosystem services and their intermediate components and (4) the indicator-based evaluation of all identified ecosystem services and

their intermediate components. By that, we achieve an "Ecosystem Service Pedigree" with four levels: from stakeholders, benefits, ecosystem services to intermediate components. By listing a wide repertory on each level of the pedigree, multi-option is offered and allows individual adaptation to the conditions of the study area. The purely anthropocentric concept of ecosystem services is enhanced by causal linkage with ecosystem functions and processes as intermediated components.

The proposed framework is currently applied to selected ecosystem types in Northeast Germany using case studies on local and regional scale. Results of the proposed approach can also serve as a decision support tool to weigh up land use options and management options in planning processes especially in the context of sustainability, climate change and efficient use of subsidies.

J2-O10: Economic instruments in the conservation of water-related ecosystem services

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One of the prognosticated effects of global climate change in Brandenburg is the decrease of summer precipitation. In line with higher temperatures this will put ecosystems under severe stress and might affect the ecosystem services they provide. The main instrument in water resource conservation in the EU is the Water-Framework Directive (WFD). In this research the main stakeholders in implementing this relatively recent environmental law are being interviewed. In these semi-structured interviews the goal is to identify the main ecosystem services targeted and what instruments are used to achieve the objects of the WFD. The focus is on the economic instruments used in implementing these measures. In theory economic instruments should help to increase efficiency and flexibility. One finding of the research is that in some cases the economic instruments are used to boost acceptance of otherwise unpopular command and control instruments in environmental law. There are also some conflicts with existing environmental laws like the Habitats Directive. Altogether, the successful implementation of the WFD in Brandenburg is still a long way off.

J2-O11: Contemporary evolution in botanical gardens

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According to the „Global Straetgy of Plant Conservation" (GSPC), 60% of all endangered species are to be held *ex-situ*, and 10% to be used in reestablishment programmes. However, due to drift, hybridisation and selection the genetic constitution of *ex-situ* populations may change under artificial conditions so that they might not be suitable for reestablishment in their natural habitats any more.

In a common garden experiment, we compared the same half-sib families of populations of two plant species that are managed in botanical gardens for several generations (founder populations) with their original populations in the wild. We tested whether descendent founder populations have a lower fitness under stressful conditions (drought, interspecific competition) as compared to their ancestral wild populations. We also compared germination rates of garden and wild populations.

Germination rates were significantly higher in garden populations than in their corresponding wild populations, indicating a loss of seed dormancy in the garden populations. Further, the number of flowers and seeds was higher in garden populations than in wild populations. Our data also suggest a loss of adaptation to stressful conditions in garden populations, but not for all botanical gardens studied.

We conclude that unconscious selection and contemporary evolutionary processes do occur in botanical gardens but depend on the specific conditions within the gardens as well as on the time span the plants are cultivated. Therefore, to keep *ex-situ* collections suitable for nature conservation purposes, appropriate measurements to avoid different selection pressures in the *ex-situ* collection are of high importance.

Poster Presentations

J2-P1: Do water level, precipitation and seed origin affect growth of Cnidium dubium?

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Flood meadows along large rivers offer suitable habitats for many rare plant species and are of great conservation value. Floodplains are hydrological dynamic ecosystems and generally flooded in winter and dry during summer. These dry periods may increase due to reduced summer precipitation as projected by climate change scenarios. In the project KLIMZUG-Nord, which aims to develop adaptation strategies to climate change in the metropolitan region of Hamburg, the question arose if *Cnidium dubium* - meadows could be adapted to reduced precipitation by raising the groundwater level in areas with drainage systems at Elbe tributaries. A garden experiment was set up to investigate the effects of water level, reduced precipitation and seed origin on young plants of *C. dubium.*

Seeds of *C. dubium* were collected from two flood meadows at Elbe tributaries in 2009 and germinated in 2010.The seedlings were planted into 1 m long pots and exposed to three water levels (20 cm, 40 cm, and 60 cm distance from soil surface to water level) in four water basins of which two were covered with rainout shelters (reducing app. 25% of precipitation). Length and width of the longest leaf, and number of leaves were surveyed for every *C. dubium* individual in July and on a monthly basis until October 2010. Finally, leaf-biomass of every individual was sampled.

First results indicate that length and width of longest leaf, number of leaves, and biomass were affected by water level and except of number of leaves by seed origin. Precipitation reduction had no significant effect on the response variables. Under these experimental conditions, a groundwater level of 40 cm under soil surface was found to facilitate best growth of *C. dubium*. Before the results can be interpreted for management recommendations, this experiment will be repeated with small sods of floodplains meadows during 2011 to include the role of competition.

J2-P2: Economic and ecological evaluation of the climate relevance of peatlands

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Natural peatlands are among the most effective carbon sinks on earth. Drainage for agricultural use leads to mineralization of peat and greenhouse gas emissions (GHG). More than 90% of the peatlands in Germany are disturbed in their water balance and degrade, which results in GHG-emissions up to 5% of the total GHG-emissions of Germany. Though only 3.3% of European peatlands are located in Germany, the country is responsible for 12% of the European CO_2-emissions from drained peatlands. 1.5% of the area of the federal state of Baden-Württemberg is covered by peatlands. The state's efforts on reducing GHG-emissions from peatlands and enhance carbon sequestration in peatlands have to consider agricultural practice and the specific biodiversity of bogs and fens.

The interdisciplinary research project "Economic and ecological evaluation of the climate relevance of peatlands in Baden-Württemberg", funded by the federal state of Baden-Württemberg, provides fundamentals for the effective management of peatlands in Baden-Württemberg with respect to GHG-emissions. Within the project, the hydro-ecological conditions of peatlands are assessed combining recent and historical field data with data from remote sensing. Extensive interviews with farmers provide information on current agricultural practice on peatlands and the economic relevance of peatlands for agricultural use. Emission values are derived from literature or ongoing research projects and applied to estimate the

GHG-emissions from peatlands in specific land use practices. A farm emission model is applied to assess the costs and the potential reduction of GHG-emissions under management scenarios. The model performs at a regional scale and here takes into account the specific economic situation of farmers as well as the specific bio-geographical situation of peatlands.

Project web page: www.moore-bw.de

J3 Maintenance and promotion of biodiversity in forests - from science to application

Oral Presentations

J3-O1: Reasons for the decline of an endangered woodland butterfly in Central Europe

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This study focuses on the reasons for the drastic decline of *Lopinga achine* (Lepidoptera Nymphalidae, Satyrinae) in Germany as well as on the habitat preferences of this species within thermophilous light forests in Southern Bavaria. *Lopinga achine*is highly threatened due to the abandonment of traditional woodland management, such as wood pasture. The extinction of *L. achine* occurred especially within areas with high mean temperatures in January and low numbers of frost days, indicating that climate change had a negative impact on the distribution of *L. achine*. However, land-use change is obviously a higher threat for this species. *Lopinga achine* preferred light forests with a canopy cover of about 40% in southern aspects and favoured habitats with high coverage of grasses. Coverage of nitrophytes was low, denoting that the excess of nitrogen depositions play a minor role as a threat for *L. achine* in the study region. Oviposition sites of *L. achine* showed a positive correlation with *Carex alba*, which suggests this sedge as an important host plant. For the conservation of *L. achine* it is advisable to reintroduce low-intensive woodland grazing in abandoned areas to maintain an open canopy cover.

J3-O2: Impacts of coppicing on woodland butterflies

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Traditional woodland management practices like coppicing (rotational cutting) and wood pasture have dramatically declined throughout Europe leading to a severe loss in biodiversity. We studied the effects of coppicing on butterfly communities of oak woodlands in the Alsace (France). Based on vegetation structure five successional stages were classified (clear cut, 2nd year, fringe, shrub, and wood). In general, butterfly diversity was high and for all successional stages characteristic species were found. Due to a high coverage of nectar resources species richness and density of migrant species was highest in the early successional stages (clear cut, 2nd year). Diversity and density of resident species peaked in early to mid-successional stages

(2nd year, fringe). The same was true for threatened species. 2nd year and fringe stages offered both a high cover of nectar resources and host plants explaining this pattern. As shown in this study, coppiced woodlands are diversity hotspots for butterflies in Central Europe. In particular early and mid-successional stages are of high conservation concern.

J3-O3: Response of epiphyte diversity to stand development in an unmanaged forest

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Unmanaged old-growth forests underlie cyclic age dynamics with several development stages. These stages are characterized by differences in forest stand structure such as stem density, tree height or canopy openness. The amount of coarse woody debris significantly varies in the different development stages. Different biotic and abiotic conditions lead to substrate and habitat changes for epiphytes. In the present study, we investigated an unmanaged high-montane spruce forest at Mt. Brocken, Harz Mountains, to assess (1) whether the diversity and composition of epiphyte vegetation is affected by forest development, and (2) whether the abundance of single epiphyte species is correlated with both a higher amount or different sizes of coarse woody debris.

Five development stages (regeneration, initial, climax, ageing, decay stage, Stöcker 1997) were replicated by five 10x10 m plots. Within those plots relevés of epiphytes (lichens, mosses, vascular plants) on living trees, snags, stumps and logs were made. Size and decay classes of deadwood objects were assessed and canopy openness was measured.

Many epiphyte species are predominantly found in latter development stages with senescent and dead trees. Response of lichens, liverworts and mosses to forest development, stand structure and substrate differs. Lichens prefer big objects (high-diameter trees, logs and stumps), whereas bryophytes are favoured by higher canopy closure. High wood decay classes promote mosses. Higher diversity of liverworts and lichens is found on logs with medium decay classes.

Adapted forest management that spares a higher amount of deadwood may have a huge impact for species conservation in forest. This especially accounts to dead trees, high-diameter logs and high stumps. Small stumps and branches, also created by commercial cutting, are no sufficient substrate for most epiphytes and would not increase epiphyte diversity in forests.

J3-O4: Oak cluster planting increases tree species diversity and enhances productivity

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Oak (*Quercus robur* and *Q. petraea*) cluster planting was introduced in Germany as an economic and ecological alternative to traditional row planting during the last decades of the twentieth century. Clusters are so called uniformly distributed 'nests' or 'groups' that consist of 20 to 30 seedlings planted in an aggregated manner with 0.25 m or 1 m initial spacing and 200 or 100 such clusters per hectare, respectively. We calculated species richness, Simpson's diversity index and stand basal area (SBA) for systematically laid plots in 15-23 year old oak cluster and row planting stands. These stands were planted in wind-thrown and clear-felled areas located at 5 sites in Baden-Württemberg and Hessen. We found that both tree species richness and diversity was significantly higher in cluster plantings when compared to traditional row planting. Moreover, SBA was significantly higher in cluster planting than row planting. We observed that SBA was positively related to tree species diversity. Our results demonstrate that cluster plantings of oak can achieve greater productivity and tree species diversity in comparison to traditional row planting. The findings suggest that significant productivity and ecological gains could be made, at least for several decades, if cluster plantings are more broadly pursued for reforestation purposes.

J3-O5: Disturbance and diversity: Avalanches increasing diversity in mountain forests

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Snow avalanches in mountain areas influence forest structure and dynamics to a certain degree. A snow avalanche run into a mountain mixed-forest down to an elevation of 610 m a.s.l. at the E-facing steep slope of Mount Watzmann, Berchtesgaden National Park, Germany, on 18 January 1986. New avalanches followed in 1999 and 2006. We recorded the vegetation dynamics in the disturbed forest from 1989 to 2010.

The forest stand development after the different disturbance events was completely different depending on (i) the immediate consequences of the disturbance (trees either uprooted and killed or "only" bent to the ground, but still living) and (ii) the frequency of the avalanche events. In two decades of observation we were able to separate 8 different succession pathways initiated by the different disturbance events hiding different development phases of the forest ecosystem in our permanent plots. The resulting consequences for species numbers per plot are also different. A patch mosaic regarding both species richness and succession pathways emerged.

Important consequences for forest stand development can be drawn: In protected areas any impact of man will change such pattern and therefore has to be omitted. In managed forests such disturbances has to be interpreted not only as a disaster (for timber production) but also

as an option (for increasing forest naturalness). Therefore a balance between clearing and maintaining such areas has to be found, meeting the needs of a broad spectrum of socio-economical and ecological demands on a sustainable forest management.

J3-O6: Impact of forest soil compaction on growth and survival of tree saplings

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The use of heavy machinery to perform logging operations in forests has increased worldwide during the last decades in order to improve efficiency and safety and to reduce the physical stress for the forest worker. However, these machines may influence the soil ecosystem as they induce soil compaction, next to rutting and churning of the upper soil layers. This affects among other things soil porosity, pore continuity, soil aeration, hydraulic characteristics and penetration resistance. Heavy soil damage due to mechanized harvesting operations may therefore impose a serious threat to several parts of the soil ecosystem such as regeneration. We performed a meta-analysis to quantify the impact of soil compaction on survival, height and diameter growth of tree saplings. In contrast with the expectations, the unweighted impact of soil compaction on these three variables was predominantly insignificant, varied strongly and was thus not always negative. A small influence emanated from the soil texture. The impact of soil compaction on growth and survival of tree saplings on relatively fine-textured soils (silt, clay) was slightly negative. This contrasted with the coarser textures (loam, sand) where compaction had no or even a slight, positive effect. A weighted analysis, based on a subset of the data, revealed an overall decrease of height growth on the compacted area, but this result should be interpreted with caution due to the limited number of observations.

Although results were less serious than expected, the biotic impact of soil compaction was negative in several cases. Harvesting activities should therefore focus on minimizing soil compaction degree and extent to prevent a decrease of soil productivity. From a methodological point of view we suggest providing more basic statistics in the articles and to include more shade tolerant tree species in future experimental designs. These species were rarely considered in this meta-analysis.

Poster Presentations

J3-P1: Do canopy type and management history influence soil seed banks in forests?

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The state of Hesse is a centre of ancient woodland distribution in Germany. One of its larger continuously forested areas is the 'Taunus' mountain range northwest of Frankfurt, with acidic beech forests being the potential natural vegetation cover. Since the late medieval deforestation periods, however, considerable portions of the forests in the northeastern part of the Taunus were managed as wooded pastures or coppices to support charcoaling and leather industry.

Coppicing has now ceased for at least four decades, leaving the aging stands in a state of conversion to timber forests. Some portions of the former coppices were replanted with conifers in the 50's. Other forests, however, were not harvested for at least one hundred years and support a rather patchy pattern of high timber beech, spruce/douglas fir and oak stands. Many of these forests have been owned and managed by local municipalities for centuries.

We were interested in the composition of the forest's soil seed banks and their significance for forest phytodiversity from a landscape perspective. In a community-owned forest (1800 ha), we therefore aimed at including all relevant canopy types and age classes of mature stands. Forest inventory data, GIS and K-means Cluster Analysis were applied to stratify the 480 patches according to tree species composition, stand age (incl. windfalls) and management history (coppice, former coppice). The seed banks of ten patches from each of the seven resulting canopy types (clusters) were sampled in a 10 x 10 m plot (composite samples of 20 cores, 4 cm depth). We applied the seedling emergence method to analyse the seed bank composition of the canopy types and calculated the similarity between seed banks and above-ground vegetation.

Our results will contribute to a better understanding of seed banks in acidic forests and will help to evaluate the conservation value of the doomed historic coppice stands.

J4 Ecological restoration of grassland ecosystems

Oral Presentations

J4-O1: Urban grassland restoration: On which plant traits rely successful colonizers?

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Species-rich grasslands are continuously declining in the cultural landscape. Potential for new low-maintenance grasslands arises in shrinking cities, where large open spaces evolve due to the demolition of surplus houses and the associated infrastructure. One idea to deal with such open spaces is to establish attractive low-maintenance grasslands and combine urban landscaping with nature conservation objectives.

We therefore tested different treatments of grassland restoration directly on degraded demolition sites in Berlin-Hellersdorf, close to remaining apartment houses. We analyze, which environmental variables (such as chemical and physical soil parameters or the frequency of dogs and people) determine the establishment success of sown target species. We characterize successful and failed target species by plant traits and compare them with resident species. With RLQ-analyses we relate environmental and trait data.

In the third year after establishment, successful restoration treatments for former demolitions sites could be determined. Target species richness was not influenced by human mediated impacts. Abiotic variables such as high stone content of the soil were negatively influencing target species richness though. Plant traits of successful target species differed from traits of failed target species and from traits of resident vegetation. For example, successful target species were of similar height as the resident vegetation. Failed target species were smaller than resident vegetation, suggesting insufficient competitive behaviour in these target species.

Our results demonstrate successful grassland restoration in urban demolition sites also under human pressure to the sites. Treatments and target species should be carefully adjusted to the abiotic settings. The combination of environmental and trait data lead to a characterization for promising treatment-species combinations.

J4-O2: Plant biodiversity maintained by scrub removal in coastal dunes

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The Sefton Coast, NW England, is one of the largest dune systems in Britain. In these dunes, *Hippophaë rhamnoides* represents an invasive shrub that has resulted in a decrease in dune grasslands and their associated flora. Invasion of *H. rhamnoides* changes the nutrient poor soil conditions of dunes due to nitrogen accumulation. The decline in biodiversity caused by *H. rhamnoides* indicates the need for management intervention.

To restore the species-rich dune vegetation, shrubland was removed in the mid-1990's. Different restoration strategies have been used in combination in the Sefton dunes, e.g., manual removal by cutting, mechanical uprooting by bulldozers especially to clear large stands, and in some areas grazing by domestic stock following the removal.

To evaluate the restoration success, areas with *Hippophaë* scrub, restored sites and dune grassland areas known to have been without scrub since several decades were compared considering various diversity levels. α-diversity was measured as the number of species at plot scale (4m²). At local scale, turnover of species (β-diversity) was expressed as average of the 1-Sørensen index across plots, calculated separately for plots with scrub, scrub removal, and grassland. At landscape scale, total species richness (γ-diversity) was measured as accumulated number of plant species.

Shrub removal regenerated landscape heterogeneity and increased total species richness (γ-diversity). Species turnover at local scale (β-diversity) was not higher in areas where scrub had been removed. Species richness at plot scale (α-diversity) reached highest values at intermediate levels of ß-diversity. Moreover, α-diversity reached highest values in areas with scrub removal, probably due to management effects, in comparison to shrubland and grassland plots, respectively.

J4-O3: Moth diversity responds to long-term (25 years) grazing in salt marshes

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We studied the effects of long-term sheep grazing in salt marshes on the diversity of moths and derive conclusive management suggestions for the conservation of invertebrate diversity in salt marshes. Study sites were located on the Hamburger Hallig, on the Western coast of Schleswig-Holstein, Germany. Between 2006 and 2009, differently managed salt marshes that have been under four levels of livestock density (0, 1-2 sheep/ha 3-4 sheep/ha, 10 sheep/ha) for 25 years were sampled according to a standardized sampling scheme.

Moth communities were found to react highly sensitive to sheep grazing and species richness of moths was only weakly correlated to vegetation parameters. We found a significant decline in moth diversity with increasing stocking density, but no difference between the lowest grazing pressure and abandonment. α-diversity explained the largest proportion of γ-diversity in ungrazed and plots grazed by 1-2 sheep/ha. In contrast, β-diversity was positively affected by intermediate stocking densities and thus became more important with increasing grazing pressure. Species richness in salt marshes grazed with 1-2 sheep/ha (α- and β_S-diversity) contributed the highest proportion to regional diversity, though no grazing treatment alone harboured all occurring moth species. High grazing densities, however, led to an impoverished moth community.

Since assessments of vegetation parameters in salt marshes do not allow conclusions on invertebrate diversity, for the evaluation of salt marsh diversity, a multi-species approach should be favoured combining plant and invertebrate assessments. A mosaic of ungrazed, extensively and moderately grazed areas would benefit salt marsh conservation.

J4-O4: What role do large herbivores play for Orthoptera in restored floodplain grasslands?

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Although the establishment of year-round grazing systems has become a common tool in conservation we have only little information about its impact on insects. Therefore, we studied Orthoptera species number and abundance in the floodplains of the river Lippe (NW Germany) in restored year-round grazed sites and, as a control, in un-restored seasonally grazed sites, both with low stocking rates. We also evaluated the importance of mole mounds and animal paths as potential oviposition sites for soil-breeding species. Our results showed that bare ground patches, which were more common under year-round grazing, were indeed frequented by females intentionally for oviposition. In species number as well as in density during nymphal period we found no differences, however, during the adult period both parameters were significantly higher in restored year-round grazed sites. Reasons for this were enhanced structural diversity on a microhabitat and habitat scale under year-round grazing and the occurrence of flood swards as a product of restoration rather than grazing system. Differences between both grazing systems were not as obvious as expected. Nevertheless, we conclude that for Orthoptera year-round grazed sites are more stable systems under changing environmental conditions and that, due to the strong decline in Orthoptera abundance within the study period, seasonally grazed sites comprise a higher risk of extinction of rare species. Based on our results, both floodplain restoration and year-round grazing promoted grassland Orthoptera.

J4-O5: Is the threatened *Gladiolus palustris* able to survive in unmanaged habitats?

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The FFH- species *G. palustris* occurs in regularly managed rich fens (Caricion davallianae), wet straw meadows (Molinion) and xero-mesic calcareous grasslands (Bromion) but also in currently unmanaged dry pine forests on calcareous soils (Erico-Pinion).

Although the Erico-Pinion-stands are thought to be primary habitat of the species they were subject to regular forest pasture with mixed flocks in former times. Large scale abandonment of this land use practice during the last century has led to an expansion of tall grasses and accumulation of thick litter layers. Currently it is unclear whether these processes will threaten *G. palustris* populations of pine forests in the long run. To assess the impact of abandonment we studied the population structure of managed and unmanaged stands (n=37). The ANOVA analyses revealed significantly higher population densities of *G. palustris* in regularly late mown Molinion stands, mid densities in regularly mown Bromion and Caricion davallianae stands and much lower densities in the more natural unmanaged Erico-Pinion stands. Following simple linear regression, cover of herbs and moisture had a positive effect on all age states, whereas the cover of litter showed a negative effect. However, even in the presence of thick litter layers seedlings and juvenile individuals could regularly be found and formed up to 60 % of the population. As long as there is no shrub encroachment *G. palustris* seems to be able to persist in open pine forests even after abandonment of pasture.

J4-O6: New concepts in restoration ecology applied in a South African arid rangeland

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Two conceptual shifts in restoration ecology are particular important for restoration practice: the application of alternative state models that incorporate feedbacks and the adaption of restoration goals to stakeholder interests and global change. We question if these theoretical advances offer new perspectives for the restoration of succulent dwarf shrub vegetation, which has in previous studies shown a high resistance to restoration efforts. We evaluated the treatments brushpacks, fertilizer, dung, microcatchments, planting, and livestock exclusion for their potential to reverse degradation trends in a Succulent Karoo rangeland. In order to detect effects of stochastic rainfall on possibly multiple trajectories the plant community could follow, vegetation sampling was conducted in three subsequent years after treatment application. Abiotic parameters sampled included erosion, salinity, and soil hydrological properties. Though most of the treatments improved the abiotic conditions, after three years only planting of long-lived shrubs could push the system over the threshold towards a vegetation structure similar to rangelands grazed with low-intensity. However, the cover of annuals was increased by livestock exclusion, fertilizer and planting. In an unusually wet year, dung treatment led to a dominance of herbaceous saltbushes, which function as soil protectors and are an important forage resource, although they are not native. The plant species promoted by the restoration treatments showed potential to induce intended feedbacks (soil deposition, facilitation) as well as unintended feedbacks (soil salinisation). Future monitoring will reveal the role of the identified feedbacks and show whether recovery of the studied system follows a successional trajectory or if there are multiple paths with alternative endpoints. The application of the modernized ecological concepts offered new opportunities to evaluate our restoration study in a broader scale.

J4-O7: What do we learn about effects of restoration actions from the trait-base analysis?

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The effects of restoration on the ecosystem functional diversity (FD) are poorly known and rarely used in restoration practice. We tested if FD is a good indicator of restoration success in plant communities, using data from fen meadows restoration project in Poland. We considered RAO and Mason indices and community weighted trait means. FD increased after restoration and after 3 years and it was higher on restored meadows than on the reference fen meadows. Concerning the traits related to dispersal, the diversity in well-developed and degraded fen meadows was higher than the diversity in the restored vegetation. We also found that restoration measures affect the community means for some trait related to anoxia tolerance, soil seed bank longevity and some dispersal traits.
In another study we explored how the analysis of life history strategy (trait-based) can be used for detecting the acute constraints for fauna in nature management on check grasslands. We used data on ant communities of such grasslands and divided the species into 4 groups, according to life history traits. One of these groups required relatively xerotermic conditions due to their life strategies. We found a dependence of the species richness on the measured soil temperature in the data from study sites in Germany, Belgium and the Netherlands for this group. The soil temperature in the crucial period for ants development was shown to be depending on the management practice. These findings gave an fact-based argument for changing and improving the management practice.

Poster Presentations

J4-P1: Experimental reintroductions in steppe grasslands of Thuringia (Germany)

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The steppe grasslands in Thuringia (Germany) contain many rare and endangered plant species and thus are of high interest for conservation. In the present these steppe grasslands are often small and strongly isolated, so that extinction events of the species e.g. by stochastic effects cannot be compensated by natural re-colonisation. Reintroduction measures into suitable habitats can compensate failed re-colonisation and thus are a potential conservation approach for these species. Consequently reintroductions are part of the LIFE project "Conservation and development of the steppe grasslands in Thuringia" started by the European Union in 2009. In order to select possible target species, in a first step, we worked out a rank list of species for reintroduction based on criteria as status of threat, responsibility of Thuringia for the world population, habitat association, but also practicability of cultivation. Three of the species with highest need for reintroduction - *Astragalus exscapus*, *Pulsatilla pratensis* and *Scorzonera purpurea* - were chosen for our project. We collected seeds from different populations of each species. From these seeds between 900 and 2200 juvenile plants per species were grown up in the greenhouse. We ask whether population size, genetic diversity and habitat type of the populations of origin influence survival and growth in the greenhouse and in the field. We also study the influence of the target site characteristics on the success of reintroduction. 900 individuals of *S. purpurea* were planted in the field in spring 2010. For the other two species *A. exscapus* and *P. pratensis* juvenile plants will be reintroduced in Thuringia in autumn 2011. Success of the reintroductions will be monitored until 2014.

J4-P2: Restoration of rare and endangered arable weeds on organic farms in Germany

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Abundance and diversity of arable weeds have been strongly declining in many European regions. The main factors for reduced agrobiodiversity are herbicides, fertilizer treatments and other components of modern agricultural management. In response to this biodiversity crisis several programs have been launched. A successful program was the field margins concept, but this method was difficult to integrate in conventional farming practice, and thus has been abandoned in most parts of Germany. Arable weeds are highly dependent on the respective type of management, and thus future programs for conservation of rare arable weeds have to establish a close and sustainable integration with innovative farming practice.

The aim of the current project is to develop applied knowledge on new methods for conservation of arable weeds within farming systems. The past decades have shown that species diversity can be higher on organic farms, and that these farmers are more willing to support endangered arable weeds in their fields. However, remnant populations of the species are often not present on the respective farms, thus, calling for transplantation from nearby populations. This type of restoration of agrobiodiversity will be explored by the new project.

The project investigates the response of seed-sown arable weeds under various management systems. Vegetation traits measured include abundance, flowering, seed production and seed bank dynamics of the test species. Possible yield reduction and basic soil characteristics will be studied as well. The farmers' practical knowledge will be included in a participatory approach.

J4-P3: 40 years of regeneration of peat bogs in Bavaria

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Peat bogs in Southern Germany suffered dramatically from drainage, peat cutting and land use intensification during the last century. In Bavaria approximately 95% of the peat bogs are degraded. Though a large proportion of raised and transition bogs has been protected by law in the seventies, it was unclear if bog ecosystems might be able to regenerate. Most bogs had already been drained in preparation of peat cutting, if not had been disturbed by peat cutting itself. The regeneration potential of natural species communities of transition and raised bogs in Southern Germany is also questioned by climate change (temperature increase, altered precipitation regime) that impacts on turf accumulation.

In 2010, the vegetation of peat bogs in the "Inn-Chiemsee-Salzach"-moraine has been re-investigated, approximately 40 years after the first mapping around 1970. Vegetation mapping was carried out by the same person who did it the first time, which guarantees both, comparability and accuracy in investigating the regeneration dynamics in such bogs.

Comparing the vegetation of slightly disturbed raised bogs between 1970 and 2010, the extensive re-establishment of growing *Sphagnum spec.* is a surprising result.

During the same time, also small peat cuts regenerated to a mosaic of heath and waterlogged depressions (former excavations) with growing *Sphagnum* from the hollow communities. This positive development only took place, where the peat cuts featured a diverse micro relief with remaining source populations. Large industrial peat cuts did not regenerate to natural or semi-natural communities.

Unexpectedly, in Spruce forests on bogs also large wind throws or deforestation were immediately followed by *Sphagnum*-colonization in cases, where further drainage had been stopped and water accumulates on site in depressions caused by logging.

At landscape scale the shift towards wide spread turf accumulation is a positive contribution to the CO_2-balance.

J4-P4: Semi-arid Savannah rangeland degradation and management: A landscape scale model.

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Arid and semi-arid savannah rangelands are threatened by land degradation. For the development of adaptive and sustainable land use strategies, it is essential to understand the underlying processes.
Main difficulties are:

- mismatch between temporal and spatial scales of management and land degradation processes
- unpredictability of rainfall
- complex non-equilibrium vegetation dynamics.

We develop a simulation model with the aim to improve our understanding of land use management in semi-arid savannah rangelands.

The study site consists of the Molopo Nature Reserve (South Africa) and surrounding rangelands. The site is characterized by sandy soil and on average 300 mm rainfall per year. In cooperation with local botanists, we selected five different vegetation classes and a representative species for each class: annual grass (*Schmidtia kalahariensis*), palatable perennial grass (*Schmidtia pappophoroides*), unpalatable perennial grass (*Aristida stipitata*), fire-susceptible small woody (*Acacia mellifera*) and large woody plants (*A. mellifera*).

The model is grid-based with a cell size of 30 m x 30 m. The spatial extent is up to 50,000 ha. The model proceeds with monthly time steps and includes three sets of processes and variables:

- environment (rainfall, soil moisture, temperature)
- management (grazing, browsing, fire, wood removal)
- vegetation (vegetation type, biomass, vigour, growth)

Classified satellite data are used for model parametrization and to initialize model simulations.

The model can be used to explore different management measures and make predictions on their effect on vegetation change (degradation, recovery, bush encroachment) at different spatial and temporal scales. It can also be used to develop management strategies to combat degradation in semi-arid savannah rangelands.

J4-P5: Re-introducing a habitat specialist into the floodplain of a pre-alpine river

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Re-introduction of species into parts of their historical range is a measure currently discussed in conservation biology. Before the actual re-introduction takes place several aspects concerning potential target sites and the plant material used need to be considered.

Our study focuses on the German False Tamarisk (*Myricaria germanica)* at River Isar near Munich. Using a standardized questionnaire, the first part of the project assessed the attitudes of representatives of four stakeholder groups (governmental and non-governmental nature conservationists, planning agencies, vegetation scientists) towards re-introduction in general and concerning the study species. The results indicate whether or not there are prejudices towards re-introduction projects, and what concerns there are for the success of a re-introduction of German False Tamarisk along River Isar.

The second part of the project is a combined field and greenhouse experiment to explore potential methods for re-introduction of *Myricaria germanica*. One aspect that needs to be considered when re-introducing a plant is the question, which life stage should be used. We describe propagation and planting of cuttings with length of 5 and 10 cm. Riverine gravel with two water levels was used, and half of the pots were fertilized to simulate eutrophication which is a problem in some pre-alpine rivers. In the field cuttings were planted at different water levels. The main research question was whether or not cutting size in combination with water level and nutrient supply influence plant regeneration measured as root and shoot production.

As the information to re-introduce German False Tamarisk collected in this project cannot consider all the factors important for a re-introduction, a perspective is given, which other factors would be needed to be considered before this type of 'assisted migration' can be implemented.

K1 Education for sustainable development (D/ENG)

Oral Presentations

K1-O1: Biodivers' ideas for a sustainable future: the European project INQUIRE

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INQUIRE (Inquiry-based teacher training for a sustainable future) is a three years lasting EU project. 17 partners from Universities and Botanic Gardens work together in the developing of a one-year teacher training course that will reach out to hundreds of teachers and their pupils in 11 European countries. The course will run through 14 Botanic Gardens and Natural History Museums – some of Europe's most inspirational cultural and learning institutions. These places will act as catalysts, training and supporting teachers and educators to develop their proficiency in Inquiry-Based Science Education (IBSE).Two science education research institutions - the King´s College in UK and the Institute of Biology Education of the University of Bremen – work together to ensure project progression and evaluation (Vergou et al. 2011).

The subject content of the INQUIRE training course focuses on biodiversity conservation (ICSU 2002) and climate change as a means of engaging young people in this critical discourse and equipping them for personal and collective decision making. It will address the needs of 9-14 years old learners.

As a first evaluation step the partners' different approaches to IBSE are investigated by a questionnaire survey and an analysis of national IBSE materials and course plans. The findings show the broad range of ideas and approaches of IBSE in the context of biodiversity for a sustainable future.

K1-O2: Lernen und Lehren in der Grünen Schule Oldenburg

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Entdecken, Beobachten und Experimentieren in der Natur - das ist das Motto der Grünen Schule, die 2009 im Botanischen Garten Oldenburg eröffnet wurde. Initiiert wurde das Projekt von der Didaktik der Biologie und dem Botanischen Garten. Die Grüne Schule richtet sich an zwei Zielgruppen:

1. Schüler forschen in der Grünen Schule

Zielgruppen: Kindergärten und Schulen aller Art
Ziele: Durch die praktische Tätigkeit in der Natur soll ein Beitrag zur Bildung für nachhaltige Entwicklung (BNE) geleistet werden. So sollen Schüler nicht nur für botanische und ökologische Themen begeistert werden, sondern auch hinsichtlich des verantwortungsbewussten Umgangs mit der Natur und ihren Schätzen gefördert werden. Dazu werden ökologisch relevante Themen wie z.B. Südfrüchte oder nachwachsende Rohstoffe sowohl hinsichtlich ihrer naturwissenschaftlichen Implikationen als auch hinsichtlich ihrer umweltethischen Relevanz hin untersucht.

2. Grüne Schule in der universitären Lehre
Zielgruppe: Studierende des Lehramts Biologie
Ziele: Studierende lernen die Grüne Schule im Rahmen von Seminaren kennen, in denen sie sich der Planung von Unterricht widmen. Hier besteht die Möglichkeit, die selbstständig entwickelten Unterrichtskonzepte umzusetzen und Schüler während ihrer Tätigkeit zu begleiten und zu beobachten. Studierende lernen in diesen Zusammenhängen die Interessen und Vorstellungen der Schüler, aber auch Lernhindernisse und Fördermöglichkeiten praxisnah kennen. Zudem trainieren sie Auswahl und Anwendung geeigneter Methoden und Medien, Arbeits- und Kommunikationsformen.
Im Rahmen von Bachelor- und Masterarbeiten werden Unterrichtskonzepte entwickelt, erprobt und bis hin zur Publikation optimiert.

K1-O3: The module bioinvasion of the pacific oyster in the Wadden Sea

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After over-harvesting the populations of the native European Oyster *Ostrea edulis* more than 100 years ago (Reise et al. 1989), there had been several attempts to settle different oyster species of the genus Crassostrea in the Northsea. In the middle of the 20th century the Pacific Oyster *C. gigas* was successfully introduced into an aquaculture in the Oosterschelde, an estuary at the Dutch coast. This led to a spreading of the Pacific Oyster in northern direction along the Dutch coast reaching the Wadden Sea around Texel in 1980 (Drinkwaard 1999). By now *C. gigas* has outspread throughout the Wadden Sea of Lower Saxony (Wehrmann et al. 2007).

In the school laboratory project "Backstage Science" the University of Bremen offered a 4 hour module called "Bioinvasion in the Wadden Sea" to deepen the ecology education of upper school classes of Bremen and Lower Saxony. This module was contextualised using a role play as an introduction in which the students (N=159) adopted different characters of a fictive East Frisian village. The following experimental phase was meant to support the components of experimentation competence (Hammann 2004).

The so-called "Backstage-Talk" following the module invited Dr. Achim Wehrmann to give the students the possibility to communicate with a "real" scientist who is actually investigating that topic.

The aim of this evaluation study is the analysis of how the visit of the school laboratory "Bioinvasion in the Wadden Sea" of the University of Bremen influences the students' interest in biology, the ecological subject knowledge and its communication. Data collection was conducted using quantitative and qualitative methods (questionnaires in a pre-post test design and videos). Results will be presented during the annual meeting 2011 of the GfÖ in Oldenburg.

L1 Remote sensing approaches in in ecological research and application

Oral Presentations

L1-O1: Leaf spectral features to separate exotics from natives in Mediterranean dunes

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Portuguese dune ecosystems are severely affected by invasions of trees and shrubs of the genus Acacia. To understand potential ecosystem changes on a landscape scale and their management requires detailed distribution data on the exotics.

In order to map the spread of the exotic tree *Acacia longifolia* which acts as an "invasive engineer" in these dune ecosystems we gathered high resolution hyperspectral airborne imagery and LiDAR data along a coastal strip of 35km in Mediterranean southwest Portugal covering Nature Reserves, RAMSAR and NATURA 2000 sites. For interpreting the hyperspectral data, it is important to understand the spectral variability of the characteristic species via field spectra analysis. We used an innovative method, the ASD plant probe, which offers a great advantage over the common hand held approach as leaf spectra can be taken in the field almost under laboratory conditions.

Field spectra of characteristics shrubs and trees in the stabilized dunes between Sines and Pinheiro da Cruz in southwest Portugal were sampled. With the ASD plant probe we took around 1600 measurements of in-situ leaf spectral in only 3 days under laboratory conditions.

Based on these field spectra we present a spectral library of the dune vegetation of our study site. The spectral library will be screened for spectral separable groups of species (in particular invasive shrubs), higher taxonomic groups (genus, family etc.) and life forms. In particular, spectra of *A. longifolia* at different sites will be compared with other invasive and native species based on biochemical features that allow distinction of spectra. Furthermore, advantages of the plant probe for gathering clean spectra in comparison to the hand-held approach are highlighted.

L1-O2: A novel non- invasive method in grassland assembly

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We developed a Mobile Field Positioning System called FIELDSCREEN for automated and highly reproduced measurements of vegetation in field experiments. The FIELDSCREEN can be equipped with various sensors, ranging from normal cameras to spectrometer or hyperspectral camera systems. Custom made control routines enable repeated and automated measurements over the course of days and seasons. From the raw data derived from the sensors we aim to test how feasible it is to extract ecological data such as the spatial spread of species (cover), species identification (presence data), species phenotypes and phenological stage (traits) as well as high- resolution reflectance and sun- induced- fluorescence of the canopy. This measurement system is currently installed over a grassland assembly experiment, the Habitat Garden where we aim to correlate traditional ecological with non- invasive high resolution census methods. This experiment was started in December 2007 with two different grassland habitats (dry vs. mesic grassland) and two different initial diversity levels (2 grass and forbs vs. 7 grass and forbs). The experiment is designed to test the strength of priority effects in assembly over time in response to sowing differently diverse seed mixtures as well as assessing what traits allow for successful invasion of adjacent plots.

Here we present initial achievements and critically assess the strengths and limitations of such a system in relation to more traditional ecological methods.

L1-O3: Hyperspectral mapping of vegetational continuum and habitat assessment parameters

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Hyperspectral remote sensing may considerably contribute to the mapping and monitoring of vegetation structures forming oligohemerobic ecosystems. Traditional imaging techniques assuming discrete vegetation units as predictable, natural entities often fail to provide valuable information on vegetation dynamics such as succession processes and invasion of species originated in transitional ecotone areas. For the purpose of examination and assessment of plant species behavior in a management of openland habitats with grazing mammals, vegetation of the nature reserve 'Döberitzer Heide' is modelled and spatially predicted as a continuum. The non metric multidimensional scaling method was applied to project species similarities of abundance data collected for 72 field plot into a 2-dimensional ordination space based on rank ordered Bray-Curtis distances. A new approach was developed defining species abundances as realizations of a random variable within ordination space. By the use of spatial correlation functions the variance structure of diagnostic- and differential species was determined and subsequently predicted adapting a Kriging estimator. In the context of the

European habitats directive vegetation units under different conservation status were re-aggregated using a functional relationship between species composition, structural plant parameters and abiotic environmental gradient. For an empirical coherence analysis spectral reflectance data of representative vegetation units were collected and statistically analysed for wavelength dependent spectral discrimination power. PLS-regression was then used to model ordination axes metrics. The resulting models were applied to hyperspectral image data for 2009 and 2010. On the basis of Kriging estimations within the ordination space the vegetation continuum, the occurrence probability as well as assessment parameters for different FFH habitat types could be spatially explicit predicted for the study area.

L1-O4: Monitoring of forest resources using multi-source remote sensing and GIS

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This work focuses on the application of remote sensing data to support sustainable development of forest resources in Indonesia with two specific topics: (1) land cover classification combining optical sensor and texture features, and (2) development of a non-destructive approach for above ground biomass (AGB) employing multi-source remote sensing data. We use different techniques for the classification combining multi-source and multi-resolution remote sensing data as an input. For the modelling of forest properties a statistical approach and non-parametric approach were selected. Landsat ETM data, vegetation indices, image transform layers, texture features, DEM were selected to perform the modelling. The performance of generated models was then assessed using independent test dataset.

Information provided by reliable land cover map is useful for the forest authorities and related agencies to support sustainable forest management, whereas the generation of the non-destructive approach to model forest biophysical properties is required to assess the forest resources more efficiently and cost-effective. This work considers two study sites over tropical rain forest landscape in Indonesia: (1) a tropical lowland forest characterized by different successional stages and complex vegetation structure in East Kalimantan, and (2) tropical peatland forest in Central Kalimantan.

This study found that combination of spectral information of Landsat ETM data and spatial information generated from Geostatistics texture features improves the cover classification accuracy. Modelling of biomass and functional forest parameters using remote sensing resulted in promising results given asymptotic problem of the satellite data and model transferability. Fusion of SAR data and optical sensor enhanced the classification over tropical peatlands and should be considered given the availability of the satellite data.

L1-O5: Risk estimation of agricultural land use for nature protection areas

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The research project investigates how to arrange demands of nature protection with the requirements of surrounding intensive agricultural production. It is supported by the "Deutsche Bundesstiftung Umwelt" (DBU). The valley of the Peene River is situated in the East of Mecklenburg-Vorpommern, Germany. The investigation area includes a nature reserve with 3,400 ha and about 2,800 ha arable land which is located directly along that border. The Peene River is one of the last relatively intact rivers in Germany. Here one of the biggest linked lowland fens of Europe, with an exceedingly rich nature, can be found. Because of the long borderline of this nature reserve, agricultural impacts are possible.

For the estimation of this potential risks, a practicable method was developed by means of GIS (Pfeiffenberger and Fock 2010). For an efficient use of financial resources a preselection of affected areas was made. It founds mainly on available and official digital data like aerial pictures, elevation models, biotope maps and administrative data used for agricultural subsidies (InVeKoS). Thus it can be realised by relative low effort and it is transferable to other regions.

The risk potential is derived from criteria like: water and wind erosion, contamination by fertilisers and pesticides, as well as the degree of nativeness and endangerment of habitats and the degree of disturbance. All criteria were valued, weighted, classified and finally calculated in a risk matrix. Results of risk analysis and derived measures will be presented.

L1-O6: Feature selection from high resolution remote sensing data for biotope mapping

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Mapping of Landscape Protection Areas with regard to user requirements for detailed land cover and biotope classes has been limited by the spatial and temporal resolution of Earth observation data. The synergistic use of new generation optical and SAR data may overcome these limitations. The presented work is part of the ENVILAND-2 project, which focuses on the complementary use of RapidEye and TerraSAR-X data to derive land cover and biotope classes as needed by the Environmental Agencies. The goal is to semi-automatically update the corresponding maps by utilising more Earth observation data and less field work derived information. The main part of this work concentrates on the process of feature selection. Based upon multi-temporal optical and SAR data various features can be computed. The resulting information stacks can easily exceed hundreds of layers. The goal of this work is to reduce these information layers to get a set of decorrelated features for the classification of biotope types. This is realised by a feature extraction and pre-processing, followed by a feature selection (regression analysis to remove redundant information and a class separability analysis). For the remaining features and for every class combination present in the study area different separability measurements are computed. As result there is a set of features for every class providing the highest class separability values. Finally an evaluation of the results by employing an object-based classification approach and to assess how classification accuracy changes with various numbers of features is performed. The study is carried out for two case studies: 1. Rostocker Heide; MV and 2. Elsteraue, SN.

L1-O7: Advances in the analysis of GPS tracks to assess grazing pattern and intensity

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Using GPS collars, we studied spatio-temporal grazing patterns of tended goat herds from three villages in southern Morocco. We also assessed the effect of recording interval on recorded travelling distance. Grazing patterns were generally similar but sometimes idiosyncratic in relation to villages and seasons. In non-linear regressions, the decay of grazing intensity with increasing distance was described better with power functions compared to inverse or exponential functions. The exponents ranged from –1.69 to –2.18, demonstrating that the null model (–1) is not valid, but the goat grazing was extremely clumped around the stables. To investigate this clumping further, we defined as grazing concentration (*GC*) the ratio of the actual exponent to an exponent of –1. Finally, we found that the relationship between GPS recording interval and recorded trajectory length was described well by an exponential function with constant, which in turn allows extrapolation from data with longer intervals to the actual distances travelled. This first comprehensive description of the grazing behaviour of goats in North Africa provides invaluable data for management decisions and for parameterization of grazing models. The proposed grazing concentration measure and our regression approach to determine true trajectory lengths are important contributions to rangeland ecology in general.

Poster Presentations

L1-P1: New options for near-infrared reflectance spectroscopy (NIRS) in Ecology

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Broad scale ecological research often suffers from insufficient spatial and temporal replication. Near-infrared reflectance spectroscopy (NIRS) offers the opportunity of rapid and cheap measurements of many chemical constituents in organic materials. Here, we present calibrations models for C, N, P, K, Ca and Mg concentrations as well as fibre components in aboveground grassland community biomass. Although complex species mixtures across a wide gradient of agricultural grasslands were analyzed, developed prediction models were highly accurate allowing simultaneous measurements of these parameters. Additionally, we tested a device that reduces the amount of required sample material by more than 95 %. The results obtained are supposed to mark a relevant methodological progress that significantly enlarges the potential fields for the application of the NIRS technique in ecological research.

L1-P2: New insight in Ellenberg indicator values: Prediction and validation with NIRS

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Ellenberg indicator values are very widely used ecological tools to elucidate relationships between vegetation and environment in ecological research as well as in the practice of environmental planning. However, they are mainly deduced from subjective observations such as expert knowledge and are thus subject of ongoing discussion. We researched if Ellenberg indicator values can be directly extracted from the vegetation biomass itself. Mean Ellenberg “moisture” (mF) and “nitrogen” (mN) values of 141 grassland plots were related to nutrient concentrations, fibre fractions and spectral information of the aboveground biomass. We developed calibration models for the prediction of mF and mN using spectral characteristics of biomass samples with means of near-infrared reflectance spectroscopy (NIRS). Furthermore, we tested un-weighted against cover-weighted values. Models were developed by using partial least-square regression (PLSR). Prediction goodness was evaluated with an internal cross-validation procedure and an additional external validation data set. NIRS calibrations gained promising results. Accurate predictions of Ellenberg mN were obtained, while calibrations for Ellenberg mF were less precise. Cover-weighting did not improve outcomes. Both Ellenberg mN and Ellenberg mF showed significant and strong correlations with some of the nutrient and fibre concentrations in the biomass. Against expectations, Ellenberg mN was much more closely related to phosphorus than to nitrogen concentrations. To our knowledge, we for the first time showed that both mean Ellenberg indicator values could be directly gathered from samples of the aboveground biomass itself. This underlines the appropriateness and usability of these values for ecological studies, especially in grasslands ecosystems. An application of NIRS technology to measure Ellenberg mF and mN is proven to be feasible. Furthermore, we conclude that the Ellenberg mN value should be seen as a nutrient or productivity value in grassland ecosystems, not a single nitrogen value.

L1-P3: Quantification of biodiversity and forest structure using HyMap and LIDAR data

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Understanding patterns of biodiversity and the linkage to forest structure is a key issue in ecological research and conservation in complex forest ecosystems. Spatially comprehensive assessments of biodiversity and forest structure require the use of remote sensing techniques. Airborne hyperspectral and LIDAR imagery promises to provide the required accuracy and information content to address these issues.

We investigate plant biodiversity and forest structure in different layers of a mixed temperate forest in the Bavarian Forest National Park, Germany, using airborne HyMap and LIDAR data. The data was acquired in 2009; ground information was collected in 102 inventory plots. Data analysis was conducted by means of the Random Forest regression tree algorithm.

We list a collection of biodiversity and forest structure metrics that could be derived successfully. Furthermore, we present the driving factors that govern the predictability of these metrics. The latter are subsequently used to predict the spatial patterns across the whole study area.

L1-P4: Remote sensing of ecotones in a heterogeneous landscape

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Detailed vegetation maps are required for conservation planning and management. For such maps, a meaningful generalization of the floristic pattern is required and frequently attempted with classification approaches. Delineated discrete units are however often arbitrary since natural vegetation rarely exhibits sharp boundaries. Such approaches may thus be inapt for a detailed description of spontaneous vegetation. Alternatively, ordination methods can be used to describe the prevailing compositional variation as floristic gradients. This approach has been used previously to derive gradient maps that show floristic patterns in continuous fields.

In the present study, gradient mapping was used for the first time in a heterogeneous landscape (30 km²) with intricate and gradually changing floristic patterns (Wahner Heide, Germany). We tested the novel method Isometric Feature Mapping for its generalization ability against established ordination techniques. Isomap preserved 74% of the original floristic variation (195 vegetation records) in a three-dimensional solution. This was considerably more than achieved by the competing ordination methods. The resulting floristic gradients (i.e., Isomap axes) were related to imaging-spectroscopy data (HyMap) using Partial Least Squares regression (PLSR). The regression equations (one for each dimension) were subsequently applied on the image. The PLSR models showed model fits ranging from $R^2 = 0.59$ to $R^2 = 0.73$ in calibration, and from $R^2 = 0.55$ to $R^2 = 0.69$ in tenfold cross-validation. The combination of Isomap ordination and imaging spectroscopy showed thus promising results for detailed mapping of complex ecosystems: the resulting gradient map provided in-depth information on floristic vegetation patterns that can be related to underlying environmental gradients.

L1-P5: Multiseasonal mapping of tidal floodplains at the Elbe estuary

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The tidal floodplains of the Elbe estuary represent a highly dynamic ecosystem. Occurring plant species (especially reeds and tall forbs) are well adjusted to the ever-present changes between high and low tide. Winterly storm events introduce a high degree of natural disturbance like abrasion of reed close to the waterside and its deposition farther away.

Due to human activities, the tidal wave has been altered drastically during the last decades both in shape and amplitude. It is expected that climate change will provoke additional changes with most likely effects on the natural disturbance dynamics and thus vegetation patterns; a degradation of the ecosystem and a weakening of the natural dike protection capacities seem possible. Despite of the difficult accessibility of these areas it is therefore of high importance to reliably detect and monitor changes in the vegetation. The application of hyperspectral remote sensing holds great potential. Within the framework of the KLIWAS project “estuary vegetation and dike protection” we therefore investigate the potential of hyperspectral remote sensing for the accurate and extensive mapping of species composition. The focus lies on disturbed areas (abrasion and deposition areas) and their development across the year. In 2010, three flight campaigns in spring, summer, and fall were implemented for selected areas along the Elbe estuary. The applied sensor (AISA Eagle) delivered a spatial resolution of 1m. Simultaneously with each flight campaign, vegetation samples were taken on the ground; percentage of coverage for each species (green as well as dead plant material) were recorded. The vegetation samples were subjected to ordination in order to extract the major gradients in plant species composition. These gradients were subsequently regressed against reflection and mapped.

L1-P6: Using remote sensing for spatio-temporal analyses of bud burst in forest trees

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Bud burst is an important quantitative, phenological trait that marks the beginning of the vegetative period in trees. In common garden experiments the onset of bud burst revealed a relatively high level of heritability and was furthermore controlled by environmental conditions. Still there is a lack of knowledge to which part temperature, water availability, winter chilling or latitude or other factors are involved in this complex mechanism and to which degree the trait is genetically controlled. More field research is needed but so far has been limited to relatively small areas and was difficult to maintain for long periods of monitoring. Remote sensing might be useful to study bud burst over many years and at any geographic location of choice. In a feasibility test we chose four major European trees species, silver fir (*Abies alba*), norway spruce (*Picea abies*), beech (*Fagus sylvatica*) and oak (*Quercus spec*) at more than 40 sites distributed across Germany. Minimum study area was 20 ha and should be covered by just one of the four tree species. Our goal was to determine bud burst using the Normalized Differenced Vegetation Index (NDVI) which is correlated with the photosynthetic activity. We used data from March to June in the years 2003 and 2006 to 2009 collected by two satellites. One satellite (Landsat) provides high spatial resolution (30x30 m) but low temporal resolution and a second one (MODIS) provides high temporal resolution but low spatial resolution (250x250 m). For each year, the course of the NDVI was compared to data of bud burst from phenological gardens. We will present first results on the suitability of satellite data to analyze spatio-temporal features of bud burst for several forest tree species. Since bud burst was shown to be related to global change effects like rapid temperature rising, our results may be helpful to develop models on bud burst in climate change scenarios.

L1-P7: A new type of sap flow sensor

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Due to its simplicity, reliability and affordability, the well known Granier sap flow sensor is accepted by several scientists over the world. However, the technique has always some shortcomings, which include: 1). Granier technique determines arbitrarily the sap flow to a zero value every night. This contravenes the possibility of nighttime transpiration and the fact of refilling process of tree body during the night. 2). The technique ignores the effect of natural temperature gradients of the sap-wood being measured, which range between +/- 1.5 °C and can cause considerable error in the results. In this work we present a new sap flow sensor setup that corrects these error sources and improves the accuracy significantly using 4 needles instead of only two.

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