

GfÖ₂₀₁₄

44th annual meeting



Integrating ecological knowledge into nature conservation and ecosystem management

Key notes

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Hildesheim | September 8th-12th

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The 44th annual conference of the Ecological Society of Germany, Austria and Switzerland (GfÖ) is taking place from 8th to 12th September 2014 at the University of Hildesheim. Host of the conference is the RG Ecology and Environmental Education, Institute of Biology and Chemistry, University of Hildesheim.

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Dear friends and colleagues,

I warmly welcome you to the 44th Annual Meeting of the Ecological Society of Germany, Austria & Switzerland (GfÖ) in Hildesheim, one of the oldest cities in Lower Saxony. The city was heavily bombed in spring 1945. However, the famous Hildesheim Millennium Rose tree reminds us that life is stronger than war: eight weeks after the levelling and burning of both the Cathedral and its rose tree, 25 new shoots appeared from a root buried by debris. Similarly, Hildesheim bloomed again to a buoyant city and the major churches and much of the medieval centre were reconstructed. Today, the historic Marktplatz, which once was considered to be one of the most beautiful market places in the world, and many other touristic attractions invite you to take a walk through the charming city that hosts our this year's meeting.



With approx. 6000 students, the young University of Hildesheim is one of the smaller universities in Germany. The University is characterized by a very personal and creative atmosphere. The combination of theory and practice is a guiding principle of the University Foundation. The Hildesheim University is thus a perfect place for ecologists from all around the globe to convene at the 44th Annual Meeting of the GfÖ meeting, listening to high profile keynote speakers and thought provoking lectures, participating in motivating workshops, visiting the highly diverse poster presentations and enjoying the extraordinary excursions. By taking a close look at the programme you will agree that the organizing committee has done a great job in providing the perfect framework for '*integrating ecological knowledge into nature conservation and ecosystem management*'. Let me use this opportunity for thanking all the many people involved for making this event possible. I am very sure that with the background of the beautiful city of Hildesheim and its marvellous history, our conference will capture the growing influence of the GfÖ on scientific ecology, and will set the stage for the future development of our fascinating discipline. We as participants now have to do our best to be among avant-garde performers of ecology!

Integrating ecological knowledge into nature conservation and ecosystem management is of vital importance for our planet. As stated by the authors of the Future Earth Initial Design Report: "*There is growing evidence that a transformation to global sustainability is necessary to secure global prosperity in the future, and this will require important shifts in governance and development paradigms.... Human knowledge and ingenuity in an increasingly interconnected world offer many possibilities for innovation to respond to these changes and to create new opportunities...*". As one of the biggest societies devoted to the science of ecology we definitely can and must accept this challenge.

With this in mind, I am looking forward to meet you at our 44th ecology festival taking place in the friendly and stimulating atmosphere of Hildesheim.

Volkmar Wolters - **President of the GfÖ**

KEYNOTES

MONDAY 13:30; AUDIMAX — Effects of large carnivores in western North America

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Large predators can help shape the structure and functioning of terrestrial ecosystems, yet until relatively recently strong evidence of top-down herbivore limitation has not been widely reported in the scientific literature. Herein I synthesize outcomes of recent trophic cascades studies involving the extirpation or displacement of large predators within several national parks in the western North America, including Yellowstone, Olympic, Yosemite, Zion, and Wind



Cave in the western United States and Jasper in Canada. These parks occur across an array of ecosystems, climatic regimes, and topographic settings. Recently compiled age structure data for deciduous trees at each of these parks, along with historical observations by park biologists regarding woody browse species, indicate major impacts to woody plant communities by ungulates following the extirpation or displacement of large predators. Declines in long-term tree recruitment indexed additional effects to plant communities and ecological processes, as well as shifts towards alternative ecosystem states. In some systems, changes in riparian plant communities translated into altered river processes and channel morphology

The reintroduction of wolves (*Canis lupus*) into Yellowstone National Park in 1995/96, after a 70 year absence, allowed for studies of trophic cascades of an intact large predator guild, elk (*Cervus elaphus*), and plant species such as aspen (*Populus tremuloides*), cottonwoods (*Populus* spp.), willows (*Salix* spp.), and berry-producing shrubs. An increasing number of studies from Yellowstone generally indicate that the reintroduction of wolves triggered a trophic cascade with woody browse species growing taller and canopy cover increasing in portions of the park, representing a fundamental change in plant community dynamics from the previous decades of browsing suppression when wolves were absent. Although wolf reintroduction has resulted in substantial initial effects to both plants and animals, the Yellowstone ecosystem still appears to be in the early stages of ecosystem recovery. In other areas of western North America where large carnivores have been previously extirpated, their reintroduction may represent an important practice for assisting in the ecological restoration of large herbivore altered ecosystems.

Monday 15:00; AUDIMAX — Re-wilding; re-establishing the keystone role of large indigenous herbivores

Frans Vera¹

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The most influential scientific theory on nature conservation and nature management concerning the northern temperate hemisphere of the world from the beginning of the 20th century up till now is the succession theory. This theory states that when mankind ends disrupting nature e.g. by agriculture or forestry, nature will rebound spontaneously back to her original state by a certain succession of vegetation types ending with the climax stage. In the northern temperate hemisphere this is supposed to be a closed canopy broad-leaved forest, which is nowadays for most scientists the baseline for the natural vegetation.



This baseline became a paradigm and is a model for other theories, such as the natural density of large indigenous herbivores and predators in natural functioning ecosystems. Above a certain density, these herbivores can prevent the regeneration of the forest by eating and trampling seedlings and saplings. Therefore, their population must be characterized by a low density; otherwise the natural vegetation could not have been a closed canopy forest. So, under natural conditions their population must have been ecologically non-existing. However, if in fact their presence is significant and their density is too high, they must be culled in order to reach lower densities that do not have a harmful impact on the forest. Under natural conditions large predators would have helped to prevent and controlled the rising density of large herbivores. Thus, large predators would have lived in even lower densities, which in turn is an argument for culling large predators.

In this work, I will present how spontaneous developments in the nature reserve of Oostvaardersplassen (OVP) located in the center of the Netherlands, are in clear contradiction of the closed canopy forest paradigm. It shows that the ecologically non-existence of indigenous large herbivores – cannot continue to exist. There, grazing herbivores drive the succession instead of following it, as dictated by the paradigm of the closed canopy forest. The reserve lies 4.5 meters below sea-level in a polder reclaimed in 1968. It consists of a marshy part of 3.600 ha and an adjacent dry part of 2.400 ha. In the marshy part tens of thousands non-breeding moulting greylag geese (*Anser anser*) graze the extensive reed beds, creating a mosaic of

shallow water and reed vegetation, which facilitates the existence of many marsh inhabiting bird species. Before and after the moult, they congregate in open grassland in the dry part of the reserve. These open grasslands are created and maintained by wild living indigenous large ungulates such as wild cattle (*Bos primigenius taurus*), wild horses (*Equus ferus caballus*) and red deer (*Cervus elaphus*). Their numbers are naturally regulated, in other words by the available amount of food. They are the keystone species for the entire reserve, because without them, the grassland would disappear, causing a cascade of events resulting in the disappearance of many bird species in the marshy part of the OVP. This re-establishment of grazing as a biotic natural processes together with the re-establishment of abiotic natural processes like the dynamic of water resulting became the basis for re-wilding projects in the Netherlands like the grazing and flooding of the flood-plains of out large rivers.

The re-establishment of the keystone function of large herbivores challenges the paradigm of the closed canopy forest as the baseline for the natural vegetation, a paradigm that resulted in a tremendous loss of biodiversity in areas meant to preserve biodiversity, like National parks and nature reserves.

TUESDAY 09:00; AUDIMAX — Conservation challenges for saving Madagascar's endangered biodiversity

Jonah Ratsimbazafy¹

¹GERP (Secretary General of the Madagascar Primate Group), Madagascar, jonah@gerp-mg.org

Madagascar is one of the top biodiversity hot spots in the world. Extensive loss of native forests to agriculture, illegal logging, poaching, and the spread of invasive species still continue to constitute major threats to Madagascar's biodiversity. The root cause of environmental degradation is strongly linked to the poverty of the majority of



the population, but corruption and political instability with its negative repercussions on donor aid have accentuate the challenges faced by conservationists in Madagascar. Today, Madagascar faces four main challenges: stopping illegal hunting of wildlife, sustaining the expanded protected area network, ensuring that benefits derived from natural resource use are shared equitably, and promoting science as a tool to support conservation. These actions are crucial to the health of Madagascar's natural resources.

TUESDAY 14:00; AUDIMAX — The delayed effects of environmental change on endangered species - insights from a tropical island

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Land-use change, particularly the conversion of natural ecosystems to agriculture, is a major driver of population declines and hence biodiversity loss. Population ecologists typically study the impacts of land-use change by measuring how demography changes along gradients that describe the transition from natural to managed ecosystems. This approach assumes the current environment is the major driver of demographic responses.



Recent work is beginning to reveal the importance of delayed effects, but these are very poorly understood in the context of environmental change. My talk will take you to the island of Mauritius and introduce you to an extraordinarily detailed dataset on the Mauritius kestrel, an endangered tropical forest bird. Demographic data on kestrels shows a clear response to changes in the current environment, but also evidence of delayed effects. Environmental change can leave a demographic legacy over several years or over an entire lifetime depending on the mechanism. Some of these delayed effects have implications for population dynamics, implying that conservationists should take them into account when making decisions. Delayed effects pose potential problems for conservation because their impacts are likely to be removed in space and time from the environmental change causing them. This highlights the critical importance of long-term, individual-based datasets in helping us understand and respond to the delayed effects of environmental change.

WEDNESDAY 09:00; AUDIMAX — Coupled human environment systems: A theoretical, methodological, and practical challenge for ecology?

Roland W. Scholz¹

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This lecture has three parts. Part 1 introduces some history of biology and ecology foundations of the concept of environment. We discuss Humboldt (1769–1859), who introduced the understanding of organismic interaction with the environment, and how Darwin's (1809–1882) interest in the dynamics of species development was built on linking paleontological and Malthusian (human) population dynamics (and other basic ideas) to the extinction of species. Haeckel's definition (1834–1919) of ecology as the "total science of the relationship of the organism with the outer world" (1866) may be seen as a



biological reformulation of Humboldt's concept. With the emergence of succession biology (with its key concepts of climax, succession, and catastrophe), it became clear that organismic systems above the level of the individual are following the principles of homeorhesis rather than those of (i.e., set-point, control-driven) homeostasis. The above-noted concepts have been integrated in Hollings Panarchy Theory (1973), which may be understood as a system–theoretic conceptualization of the dynamics of complex ecosystems utilizing the idea of creative destruction conceived by the economist Joseph Schumpeter (1883–1950). The concept of environment added a new dimension when the energy and material/nutrient cycles were introduced (Lindeman, 1942; Odum, 1953), and the thermodynamic and biological principles of biotic systems' order (see: *A New Ecology*, Jørgensen et al., 2007) were related. Surprisingly, with very few exceptions, such as some parts of (biological) landscape ecology (Bürger, 1935; Naveh & Liebermann, 1994; Haber, 1995), ecology remained a discipline that excluded the human species. This may be useful and meaningful for understanding organismic and ecological basic principles, but we argue that this approach is insufficient for understanding the biological systems and evolution in the era of the Anthropocene (Crutzen, 2002). With the

beginning of the industrial age, human activity became a new quality, as the description of Earth system dynamics asks for the inclusion of humans in the study of ecosystems.

Part 2 first reflects on why coupled human–environment systems research developed and in what way ecology might transfer from ecology to full ecology, i.e., incorporating the activities of the human species in the dynamics of ecological systems (Bonnes & Bonaiuto, 2002). We then introduce the seven postulates of the human–environment systems (HES) framework (Scholz, 2011). The framework is based on a cell-based definition of human systems (including a body–mind view of organismic systems as suggested by Haeckel). The four-system theoretic postulates are as follows: (1) Complementarity (between human and environmental systems), (2) Hierarchy (of all levels of human systems in the range from cell to human species), (3) Interference (among the levels of the hierarchies), and (4) Feedback loops (of different orders), which may be considered methodological tools for system analysis and description. Two postulates, i.e., (5) Decisions (all activities of human systems may be described by decision theory) and (6) Environmental Awareness (the interaction with the environment has to be onto- and phylogenetically acquired) may be used to describe the action of human (and organismic) systems. And finally, there is a methodological postulate, (7) Environment First, which suggests that the study of an environmental setting has to precede the analysis of human systems. Brief insights into various applications such as the BSE crisis and biofuel production are provided.

Part 3, the discussion, illuminates in what ways research and the management of human–environment systems are challenging new forms of interdisciplinarity (Scholz, 2011) and transdisciplinarity (Seidl et al., 2013) in ecology, biology, and other sciences.

References (all cited references may be found in the following publications):

Scholz, R. W. (2011). *Environmental literacy in science and society: From knowledge to decisions*. Cambridge: Cambridge University Press.

Seidl, R., Brand, F., Stauffacher, M., Krütli, P., Le, Q. B., Spörri, A., Meylan, G., Moser, C., Berger Gonzales, M., Scholz, R. W. (2013). Science with society in the anthropocene. *Ambio*, 42(1), 5-12.

WEDNESDAY 13:45; AUDIMAX — Disequilibrium dynamics in vegetation under future climate change -patterns, causes and consequences

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Near-future climate change is likely to elicit major changes in vegetation and plant diversity. These changes will have far-reaching consequences for biodiversity and provide a major challenge for conservation management. Disequilibrium responses - which occur when vegetation comes out of equilibrium with climate - may



potentially play a key role in these dynamics, complicating forecasts and offering both challenges and opportunities for nature conservation. Understanding these dynamics is crucial for our ability to accurately predict future vegetation, dependent biodiversity and related ecosystem functioning on time scales relevant to conservation planning and society. Much theory and many predictive studies have unfortunately hitherto focused on equilibrium end-points with only slight consideration of transient trajectories, although this situation is now improving. I review what is to be expected in terms of disequilibrium dynamics in plant diversity and vegetation over the next 50-200 years, integrating information from paleoecology, biogeography and macroecology, landscape ecology, vegetation and plant ecology, invasion biology, global change biology, and ecosystem ecology. I conclude that near-future climate changes are likely to induce strong disequilibrium in vegetation and plant diversity due to migrational lags at local to continental scales, delays in local population build-up, lagged community development due to protracted successional dynamics and extinction debts, time constraints on evolutionary responses, and delays in ecosystem development. Other global change factors such as habitat loss and fragmentation and biological invasions are likely to exacerbate these disequilibrium dynamics. I will end by considering the potential consequences for biodiversity and the implications for future conservation management, as well as offering a perspective on important future research foci to improve our ability to forecast vegetation and plant diversity in a changing world.

THUERSDAY 9:00, AUDIMAX - Latest findings on the state of biodiversity: moving towards sustainable management of socio-ecological systems

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In 2010, the Convention on Biological Diversity (CBD), following the failure to meet the 2010 Biodiversity Target (halt the loss of biodiversity), adopted 20 biodiversity targets for 2020, also called the Aichi Biodiversity Targets. These targets aim at the overall conservation and sustainable use of biodiversity, tackling different biodiversity-related topics such as invasive species, societal, ecological and economical drivers of biodiversity loss, ecosystem services, and marine protected areas. DIVERSITAS and its partners, mandated by the CBD, have



recently carried analyses of the latest data on the status and trends of biodiversity to provide a midterm assessment towards the progress in the implementation of the Aichi Biodiversity Targets. This work also included an in-depth global assessment of scenarios of biodiversity change in response to environmental and socio-economic changes to inform on biodiversity trends towards 2020 and 2050. Key results of these analyses, are to be published in October 2014, and will be presented here.

To complement this initiative, work has been carried on the linkages between biodiversity and sustainability showcasing how biodiversity protection can contribute to the achievement of Sustainable Development Goals, e.g. water security, health or local development. A recently published conceptual framework to manage socio-ecological systems, focusing on the trade-offs and mismatches between the provision of ecosystem services and institutional arrangements will be presented as a way forward to improve socio-ecological systems management.

SESSIONS

ORAL & POSTER

PRESENTATIONS

Session 1 - Agriculture and biological diversity

CHAIRS: MARTIN DIETERICH, BRUNO BAUR, THOMAS FARTMANN

O1 - Agriculture and biodiversity - an introduction

Martin Dieterich¹

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Land use change largely driven by continued intensification in agriculture remains the main cause of biodiversity loss in the EU. The Common Agricultural Policy (CAP) endowed by almost 40% of the EU budget has failed to sufficiently protect biodiversity. Species and habitats dependent on agriculture have mostly been reported in unfavorable conservation status. The European farmland bird index since 1990 has steadily declined.

Recognizing environmental deficits, greening became one of the major targets of the new CAP as outlined in 2010. Greening comprises establishment of Ecological Focus Areas (EFA), maintenance of permanent grassland and cultivation of a minimum number of crops. Proposed greening measures were scaled down considerably in the negotiations leading to the new CAP and member states were granted considerable flexibility in terms of implementation. EFAs were reduced from originally 7% to only 5%. Farms with arable land 30 ha of arable land.

As proposed, the greening is insufficient to prevent continued biodiversity decline in farmed areas. This is particularly true for central and eastern European new member states. Measures towards more effective conservation of biodiversity in farmed areas include an evidence based assessment of CAP effects on biodiversity, an increase in agri-environment budgets and improvement in agri-environment measures (target based measures), additional management requirements for EFAs assuring the provision of proven benefits to biodiversity and measures for effective protection of species-rich grasslands including grassland types not listed in Annex I of the Habitats Directive.

O2 - Conservation and quality improvement of lowland hay meadows

Barbara Raufer¹, Ulrich Thumm¹, Iris Lewandowski¹, Melanie Seither², Martin Elsässer²

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Lowland hay meadows are a characteristic element of the cultural landscape in south-west Germany. Classified as "habitat type of community interest" by the European Habitats Directive 92/43/EEC, this species-rich grassland type

(predominantly used for mowing) has had special protection status since 1992 due to its high conservation value. However, the lowland hay meadows (FFH habitat type 6510) have suffered a decline in quality since designation. Land-use intensification or abandonment as well as inappropriate management are seen as chief causes of this negative trend.

The cause–effect relationships between the current conservation status of lowland hay meadows and their former and present agricultural management are diverse and have so far been insufficiently examined. The aim of this comparative study was therefore to assess the current conservation status of extensively-managed meadows in the district of Esslingen (Baden-Württemberg) and their development since the last status survey. In order to determine the influence of agricultural land use and abiotic site conditions on vegetation composition, we conducted vegetation assessments and determined the conservation status. Furthermore, soil nutrient content was measured and management information collected from the farmers. In contrast to the common assumption that lowland hay meadows have deteriorated as a result of intensification, the results indicate that their loss and decline in size, number and quality in the district of Esslingen was often due to late harvest dates and a shortage of essential nutrients. Further research on the range of suitable management systems in relation to site conditions is required to derive practical recommendations on how the plant diversity of lowland hay meadows may be conserved or improved.

O3 - Land-use intensity affects gastropod communities in alpine grasslands

Bruno Baur¹, Denes Schmera¹

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Alpine grasslands harbour species-rich communities of plants and invertebrates. We examined how environmental variables and anthropogenic impact (grazing intensity) shape species richness and community structure of terrestrial gastropods in alpine grasslands in the Val Müstair (Eastern Alps, Switzerland). Gastropods were sampled using a standardised method at 76 sites spanning an elevation range from 1430 m to 2770 m. A total of 4763 specimens representing 52 species were recorded. Correspondence analysis revealed that the grassland gastropod community was structured in a complex way with elevation and wetness of the sites as key factors. Applying linear models, species richness decreased with increasing elevation while gastropod abundance decreased with grazing intensity and decreasing inclination of the site. The grassland gastropod communities were characterized by a high beta diversity. Considering species-specific traits, fourth-corner analysis revealed that the adult shell size of snail species decreased with elevation and increased with the heat load of the sites. Our results indicate that grazing intensity and environmental filtering are the major drivers of the structure

of terrestrial gastropod communities in alpine grasslands.

O4 - Environmental impacts on the functional diversity of wild bee assemblages across different spatial scales

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More than two-thirds of wild plants depend to a certain amount on animal pollination and wild bees provide as effective pollinators an essential ecosystem service. But there is evidence that bees decline globally. The most important drivers of this alarming trend are probably habitat loss and fragmentation, the use of pesticides and global warming. Since plants have specific requirements on their pollinators, higher functional diversity of bees is thought to enhance ecosystem stability. To obtain useful information for conservation management, the aim of this study is to gain insight into the relationship of environmental factors and the functional diversity of bee assemblages across different spatial scales. It is assumed that a high proportion of agriculture areas and the use of insecticides lead to a decline of functional diversity. Functional diversity is a trait-based measurement which allows estimating how species share the available niche space. Across two different spatial scales the functional diversity index Rao's Q will be calculated for each bee assemblage, by considering trait and distribution data (presence - absence and abundance data) of wild bees. The effects of landscape context, land use intensity and climate on the functional diversity of bee assemblages across spatial scales will be examined by using generalized linear mixed models. The use of different spatial scales may help to identify scale specific processes and allows improving the monitoring of biodiversity in general. While most studies considered only species richness, the use of functional diversity offers different insights in the relationship of environment and bee. It becomes possible to estimate how the composition of bee assemblages changes under different conditions and therefore how bee assemblages may fulfil ecosystem services. These insights could be very useful for conservation management.

O5 - Impact of environmental factors on the relationship between wild bees and insect-pollinated plants

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It is a well-known fact that many potential drivers of current bee declines exist which is particularly critical because most of the flowering wild plants and agricultural crops rely on insect pollination. Environmental factors like climate changes, habitat loss, fragmentation and intensification of agriculture are

considered the most important drivers. Additionally, it is also known that insect-pollinated plants and bees live in a mutually relationship and depend on each other for high reproductive success. This study focus on the question how environmental factors, e.g. climate conditions, habitat types and land-use intensity, affect the relationship between insect-pollinated plants and wild bee species in agriculturally dominated landscapes across European countries. Here the direct and indirect effects of the environmental factors on the species richness and on the functional diversity of wild bees and insect-pollinated plants will be examined by using the method “structural equation modelling”. The functional diversity, which based on specific ecological traits, will be calculated with the “Rao’s quadratic entropy”. The results will demonstrate the importance and the direction of environmental impact (positive or negative) on the richness and functional diversity. Additionally, it is interesting to examine if the richness and the functional diversity are independent from each other and environmental factors have specific diverse effects on the two aspects of diversity. These results can be important for protecting pollinators by define potential drivers for bee decline and generally for future nature conservation. Consequently, possible nature conservation management considers different reactions of functional diversity and species richness on particular environmental factors.

O6 - Trait dependent responses of bee communities to weather and land-use

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There are a fair number of studies describing how bee communities respond to weather conditions and local land-use, but not always with consistent results. We were especially interested in whether and how the life history traits body size, social status, nesting preference and food specialization level affect these responses. We used bee sampling data (with two seasons per year and three pan-trap sampling rounds per season) from three subsequent years from the long term monitoring initiative TERENO (TERrestrial ENvironmental Observatoria). Within in a 50x90 km area in Saxony-Anhalt bees were sampled in six landscapes varying in local weather conditions and land use, with 16 sampling locations per landscape (land-use in 200 m radius buffer zone considered at trap level). We show that bees respond differently to weather conditions and local land-use in early and late season, which is more pronounced for bees with certain traits.

O7 - Targeted flower strips promote natural pest control services in potato and winter wheat

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Sown wildflower strips are increasingly established within agri-environmental schemes in Europe and worldwide. We tested the effectiveness of different types of annual flower strips specifically designed to promote functional biodiversity and natural pest control services in potato (control of aphids) and winter wheat crops (control of cereal leaf beetles) in a series of replicated field experiments over two years. The abundance of all investigated groups of aphid antagonists (Syrphidae, Coccinellidae and *Chrysoperla carnea*), and species richness of Syrphidae was enhanced in flower strips, and the number of Syrphidae and *C. carnea* eggs increased by an average of 99% and 55%, respectively, in potato fields adjacent to flower strips compared to control fields. This resulted in an average reduction of aphid densities in potato fields adjacent to flower strips by 60%. We found significant reductions in cereal leaf beetle larvae numbers (47% on average) in wheat fields with adjacent flower strips as compared to control fields, resulting in a major reduction of plant damage. Of the investigated potential natural enemies of cereal leaf beetles, abundance and species richness of Carabidae and carnivorous Heteroptera, and abundance of Coccinellidae and *C. carnea* were enhanced in flower strips compared to wheat control strips, while only the abundance of Carabidae was also increased in the wheat fields adjacent to flower strips. We conclude that targeted flower strips are an effective tool for conservation biological control.

O8 - Changes in weed communities in Switzerland over the last 90 years

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Arable weeds are among the plant groups that are most threatened in Europe, due to agricultural intensification and efficient cleaning of crop seeds. In Switzerland, a large vegetation database offered a unique opportunity to study changes in arable weed species over the last 90 years. In 2011 and 2012, we re-surveyed 515 of these locations. If the current crop type corresponded with the historical one, we recorded all plant species on plots of 100 m² and estimated their abundance.

Additionally, we explored the phylogenetic structure of these two communities using phylogenetic community assembly analysis, and assessed the change in diversity and composition of plant functional traits from historical to contemporary plots. Across all re-surveyed plots, species richness did not change significantly, but the mean number of species per plot declined dramatically by over 60%. Most species decreased in frequency, but common species stayed abundant while rare species often disappeared. Species with increasing frequency were mostly neophytes, grasses and species with high nutrient demand. Decreasing species were mostly species characteristic of traditionally managed weed communities. We found that phylogenetic clustering increased from traditionally managed to contemporary agricultural habitats. These patterns were accompanied by a decrease in the diversity, and a change in the composition of plant functional traits. The intensification of agricultural practices led to a higher degree of environmental filtering in arable fields. The loss of phylogenetic and trait variation as well as in species richness could reduce the resilience of communities and their ability to adapt to environmental changes. This suggests that more explicit conservation measures have to be taken to ensure the persistence of rare arable weed species.

O9 - The dispersal of agricultural weeds by gastropods and earthworms

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Earthworms act as seed dispersers in grassland and forests. Recent studies also reported gastropods to disperse vascular plants, ferns, mosses and lichens, mostly in forest ecosystems. In agricultural landscapes a number of weed species lack dispersal structures, and mechanisms of non-human dispersal are often unknown. The role of earthworms and gastropods for the dispersal of weeds has been poorly explored. However, a number of earthworm, snails, and slug species can be found in agri-environments. We tested the feeding behavior of two species of earthworms, an epigeic and an anecic species, as well as of an invasive horticultural pest slug being offered seeds of 12 arable weeds and three endangered herbs in the laboratory. We further tested if seeds eaten and defecated by earthworms are still consumed by slugs and the other way round, exploring potential synergistic effects on seed dispersal. Germination of seeds defecated by these invertebrates was recorded over a period of one year. Complementary video observations of artificial weed seed depots were made in an organic rye field to identify important seed consumers in the field. In a second study, we tested invasive aquatic apple snails for their potential to disperse seeds of ten weed species growing in irrigated

rice fields in South-East Asia, followed by germination experiments. Removal of seeds was also assessed in rice terraces in the Philippines. Our results support the assumption that earthworms and gastropods facilitate weed movement in the agri-environment. Seeds of most weed species were readily swallowed by earthworms and by terrestrial and aquatic gastropods, and defecated seeds mostly germinated at similar rates as control seeds. Earthworms preferred seeds defecated by slugs over control seeds. We conclude that these invertebrates are overlooked weed seed dispersers in the agri-environment, which might have important implications for re-establishing plant diversity in organic farming.

O10 - Agricultural heterogeneity as effective tool to keep spatial connectivity

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In a previous research we showed that wheat fields served as an ecological trap for individuals of a reptile species -- *Trachylepis vittata* – that move one-directionally, from natural patches to wheat fields, to their death. We extended this research to compare movements of individuals between pea and wheat fields, which commonly rotate at our study area. These two crops represent major components in our agro-landscape mosaic – the Southern Judea Lowland. At this landscape we chose 12 sampling sites: 6 including a natural patch, an adjacent wheat field and the patch-fields edge, and 6 including a natural patch, an adjacent pea field and the patch-fields edge. At each site we set-up 40 traps, ordered in two trapping arrays. Additionally, on the patch-field edge we build a 100 m-long fence that directed movement of reptiles between the natural patch and the agricultural field to five passageways. *T. vittata* abundance in natural patches remained relatively constant throughout the study period. However, its abundance in the wheat fields increased from the beginning of the sampling session till the harvest and declined dramatically to zero immediately after. Before the harvest we also found an asymmetric movement – most individuals moved from the natural patches to the fields while only few moved in the other direction. No movement was found after the harvest. Similar to the wheat fields, in the pea fields *T. vittata* abundance increased from the beginning of the sampling session till the harvest and declined dramatically to zero immediately after, with an asymmetrical movement from the natural patches to the fields compared with the other direction. In contrast to the wheat fields, in the pea fields we found that individuals of *T. vittata* kept moving between the fields and the natural patches in both directions after the harvest. At this time, population size grew very slowly. These results indicate that before the harvest, pea fields, like wheat fields, serve as a barrier for reptile movement. However, early harvest in pea fields allows reptile to survive and move between natural patches later in the spring. Consequently, mixed agricultural crops may create seasonal corridors between natural habitats and enhance persistence of natural populations, which are otherwise vulnerable to extinction due to isolation and decreased

population size.

O11- Influence of temporarily reduced tillage in organic farming on earthworms and yields

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Earthworms (EW) are known to positively influence a variety of soil properties. Also negative influence of intensive tillage measures on EW could be shown in a number of studies. Reduced tillage, introduced in conventional farming mainly to avoid problems caused by erosion, has the potential to promote EW communities and thus their provision of ecosystem services. However, the application of reduced tillage measures in organic farming is, beside a variety of possible site specific problems, mainly hindered through increasing weed pressure.

Against this background we conducted a field experiment (n=4) on the applicability of temporarily reduced tillage (TRT) in organic farming in 2012 (triticale) and 2013 (grass-clover and clover). To evaluate the potential of TRT we (i) investigated the influence of temporarily setting aside the plough on EW communities and crop yields, (ii) checked whether counting surface casts of EW is a reliable method to predict some of the characteristics of EW communities, (iii) and tried to estimate the economic consequences of TRT on field level.

EW biomass and number of individuals was always enhanced under TRT, with positive effects especially on anecic species. It became apparent, that counting of surface casts is not always a reliable predictor of EW biomass or abundance. This only worked for fields under TRT measures, while under conventional tillage surface casts can be seen more as a measure of EW activity. Yields showed no consistent trend referring to tillage measures. Fields gaining highest yields under conventional tillage did not show decreases in yields when managed without the plough, whereas fields attaining smaller yields even under conventional tillage showed significant yield decreases, when setting aside the plough only once. So on the high yielding fields TRT, besides having positive influence on EW, also had positive economic consequences, because yields were stable, while costs for diesel and labour could be reduced.

O12 - Simulation study of the effects of intensified crop management in genetically manipulated maize on arable weed flora and associated fauna

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Cultivation of GM crops with herbicide tolerance is mostly associated with changes in crop and weed management, like simplified rotations, simplified tillage and change from selective herbicides to the broadband glyphosate. All of these management practices decrease weed densities in crops and change their composition. Although weeds cause yield loss and harvest problems, they are an important part of arable biodiversity and offer food and habitat for different groups of animals.

A simulation study was conducted to analyse indirect effects of intensified cropping in GM maize on biodiversity. The dynamic crop: weed model FlorSys was used to simulate weed densities and composition of common cropping systems and probable (GM) cropping systems in two regions of France and Spain.

Results were translated into a set of biodiversity and harmfulness indicators. The presentation will show that the change from selective herbicides to glyphosate (which GM maize is tolerant to) has only smaller effects on biodiversity compared to simplified rotations. Change from a soybean-maize-wheat-maize rotation to a continuous maize cropping decreases weed species richness as well as food resources for birds, beetles and pollinators strongly. The total abandonment of tillage strongly increased biodiversity indicators in our simulation, but was associated also with high damage, and can therefore not be recommended to farmers.

O13 - The role of aquatic and terrestrial resources for generalist predators and pest control in rice fields

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Within the framework of the LEGATO project ("Land-use intensity and ecological engineering-assessment tools for risks and opportunities in irrigated rice based production systems") we investigate the food web of irrigated rice field production systems on the Philippines by studying the diversity and abundance of generalist predators. Density and community composition of spiders and potential prey were investigated using suction sampling and sweep netting early, intermediate and late

during the rainy season in 2012. We hypothesized that aquatic detritivores and herbivores contribute significantly to the functioning of ricefield food webs thereby affecting the role of generalist predators for controlling insect pest species of rice. For identifying trophic position of predator and prey species, such as planthoppers and dipteran larvae, natural variations in stable isotope ratios were analyzed. In particular, the role of terrestrial vs. aquatic prey species for spider nutrition was studied. Further, effects of landscape context (irrigated rice paddies with poorly and highly structured surrounding) on generalist predators were analysed. Data analysis is ongoing and first results will be presented.

O14 - Effect of intercropping on multitrophic interactions in an aphid-okra system in Cameroon, West Africa

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Intercropping, where multiple crop species are grown in the same field, is a traditional practice in many tropical countries. In Cameroon, West Africa, okra (*Abelmoschus esculentus*), is a commonly cultivated vegetable and the melon-cotton aphid (*Aphis gossypii*) is one of the major insect pests. The natural enemies of aphids on okra include parasitoid wasps, syrphid fly larvae, spiders and ants, and these could be utilized as natural control agents of the aphids. However, farmers often spray pesticides to combat aphid pests which also reduce the abundance of natural enemies, and further this method is costly and environmentally unsustainable. In Cameroon, many small-scale farmers practice intercropping of okra with various additional crops, but it is unknown what effect this has on the invertebrate community associated with okra, and on fruit yield. In a field experiment we grew okra with maize and bush beans at two densities (low and high) in different combinations (1, 2 or 3 species), to understand the effect on the aphid and associated invertebrate community on okra and the resulting impact on okra yield. A successful intercropping strategy aims to decrease crop pests through increasing natural enemy abundance, while optimizing crop yield.

O15 - Potential of long term perennial biomass cropping (*Silphium perfoliatum*) on diversification of soil fauna communities

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Bioenergy farming is generally associated with highly intensive soil management. Frequent disturbance leads to negative feedback on soil biodiversity and -

processes. *Silphium perfoliatum* is a perennial energy crop requesting only reduced soil management. To investigate long term effects of this new cropping system on soil fauna communities and functions, twelve fields of *S. perfoliatum* from experimental and farming sites were sampled for micro-, meso- and macrofauna, e.g. nematodes, collembolans and earthworms. Sampling and extraction took place in spring and autumn 2012 and 2013 and followed standardized ISO-guidelines, with the exception of allylisothiocyanat (AITC) use for earthworm extraction. The fields represented an artificial timeline with fields established in 2004/05, 2007, 2009, and 2011 with 3 field replicates each. Maize fields (n=3) served as control. Earthworms were identified at species, collembolans at family level, for nematodes feeding-type determination and calculation of nematode-channel-ratio (NCR) was performed. All individuals in the study were linked to their corresponding functional group. Results show, that there is a trend towards higher functional complexity and biodiversity in older *S. perfoliatum* fields, while early stages showed little differences in comparison with maize. The perennial cropping system of *S. perfoliatum* seems to build niches for a greater variety of life forms in agroecosystems and consequently facilitates versatile decomposition cycles. Based on these findings positive effects on soil processes and services are expected by increased growing of *S. perfoliatum* in agricultural landscapes.

O16 - Biodiversity in vineyards - effects of management and agri-environment schemes

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Traditional viticulture was part of a multifunctional, species-rich agricultural system including low-input grassland management and fruit production. However, in the last decades, land use changes and intensification in vineyard management have led to a separation of production and conservation areas. The fear of competition for water and nutrients between weeds and grapevines has resulted in a low tolerance attitude against weeds. In the present study we wanted to explore and evaluate the effects of different management regimes and agri-environmental measures on vascular plant species regarding cutting and soil management frequency as well as herbicide application and cover crops in vineyards. Besides species richness, we considered the presence of indicator species and structural diversity in the vineyards.

We investigated plant species diversity in 105 vineyards in three different viticultural regions in Austria. Plant species composition was recorded in spring and summer in and between the vine rows. Structural diversity was estimated based on field observation and aerial photographs.

In total, we recorded 382 vascular plant species across all regions with a mean species richness of 57 species per vineyard. Species diversity was significantly influenced by region, management type (organic, integrated production and conventional farming) and structural diversity. Organic vineyards resulted in the highest biodiversity with a mean species richness of 64 plant species per vineyard (compared to 54 of integrated and 58 of conventional vineyards). Herbicide application had a negative influence on species composition and diversity. Most current agri-environment measures in Austrian vineyards do not explicitly aim at biodiversity preservation but soil conservation and the reduction of pesticides; therefore, effects on vascular plant species diversity were in all measures but organic farming small

O17 - Herbaceous ground cover reduces nest predation in olive groves

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The simplification and homogenization of agricultural landscapes has led to dramatic losses of farmland biodiversity. Increased nest predation might be one of the mechanisms contributing to the decline of passerine populations. Ground covers are agri-environment measures aimed at halting biodiversity loss by creating high quality habitat patches embedded in a homogeneous landscape. However, they may act as ecological traps since they are preferred by breeding birds, but they could attract predators as well. To investigate whether nest predation rates is different in olive orchards with and without ground covers, we performed nest predation experiments with artificial nests. The experiments were completed during the breeding season in 2013, in two areas of southern Spain. Each artificial nest (n= 300) was placed on the ground or on an olive tree, and contained three quail *Coturnix coturnix* eggs, two were unmanipulated and the third one was emptied and injected with plaster. Ground nests were significantly more predated, irrespective of the presence of ground covers; tree nests were less predated in areas with ground cover. There was a clear separation of predator faunas between ground and tree nests, as identified from marks in plaster eggs and by photo-trapping. Rodents were the most frequent predators of tree nests and the lower predation rates in orchards with ground cover, is probably linked to a change in the foraging behavior of rodents. Moreover, in this more complex habitat rodent populations might be limited by their predators (Mustelids). This study underscores the important role of agricultural practices in preserving farmland bird communities, particularly tree-nesting species, suggesting that for this group, orchards with ground covers might not act as “ecological traps.”

O18 - Population dynamics and economic losses caused by *Zeuzera pyrina*, a cryptic wood-borer moth, in an olive orchard, Egypt

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The leopard moth, *Zeuzera pyrina* L. (ZP), is an invasive pest from Europe with an increasing importance in N Africa. Seasonal and yearly dynamics in trap catches for ZP over a 10-year period (2002 -2011) in an infested olive farm in N Egypt were studied. The ZP had an annual biological cycle with one or two peak flights. Time series analysis (ARIMA) showed a clear 2-year cycle of trap catch. This regular cycle is likely related to the “on/off” bearing pattern of the olive. In addition, we observed two outbreaks of ZP in 2001 and 2009. Field observations of the larval damages in both “on” and “off” years (2006, 2007) showed that infested trees has fruit yield losses of 37 –42%. The loss was estimated to 2.1 to 4.8 t /ha with a value of estimated 1400 to 3200 US\$/ha among susceptible varieties. During the yield-losses study we observed spatial patterns of related to intercropping. In 2009, we quantified the response of 4 susceptible and resistant olive varieties in different cropping systems within and between adjacent plots. The results suggest both within and between plots influence of resistant varieties, which could assist in ZP management.

O19 - Response of Orthoptera communities to succession in alluvial pine woodlands

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During the past 150 years forest management has dramatically altered in Central European woodlands, with severe consequences for biodiversity. Light forests that fulfilled variable human demands were replaced by dark high forests that function solely as wood plantations. In the Alps, by contrast, open woodlands are still present because the traditional land use as wood pasture has remained and physiological conditions favour natural dynamics. The aim of our study was to investigate the effects of succession on the Orthoptera communities of alluvial pine woodlands in the northern Alps. Orthoptera showed a clear response to succession, with each successional stage harbouring a unique assemblage. The influence of succession on species richness and abundance were identical: The values were highest in the intermediate and lowest in the late seral stage. The diversity and abundance peak in the mid-successional stage probably reflects a trade-off between favourable ambient temperatures for optimal development and sufficient

food, oviposition sites and shelter against predators. Food shortage and easy access for predators seemed to be limiting factors in the early successional stage. In contrast, in the late successional stage adverse microclimatic conditions probably limit Orthoptera occurrence. Although all three successional stages of the pine woodlands are relevant for conservation, the early and mid-successional stages are the most important ones. Conservation management for Orthoptera in this woodland type should aim at the reintroduction of cattle grazing and the restoration of the natural discharge and bedload-transport regimes of the alpine rivers.

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P1 - Land-Use Intensity and Stability of Ecosystems

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Through an ecological network model, we address the relationship between ecosystem's complexity, stability and productivity and how it is affected by land-use intensity, measured as the removal of biomass through harvest. We test different harvest intensities and distributions among species in order to assess the impact of land-use intensity in the ecosystem's stability, as both local stability and biomass variability, as well as in the proportion of species extinctions. We found that land-use intensity triggers a decrease in both metrics of ecosystem's stability, while also leading to a high proportion of species extinctions. In this context, our results support the hypothesis that a biomimetic harvest configuration, implying low harvest rates distributed among several producer's species, could mitigate these impacts while also enhancing productivity.

P2 - Sycamore pastures in the Northern Alps: Biodiversity Cultural history and *Tayloria rudolphiana*

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Sycamore pastures are a traditional land management system in the montane region of the Northern Alps. The sycamore trees (*Acer pseudoplatanus*) on these pastures provide shelter for grazing animals and they used to be important for woodland products such as timber or leaves. Old sycamore trees on these pastures are especially rich in epiphytic cryptogams with up to 80 bryophyte and lichen

species co-occurring on one tree and can thus be considered as hotspots of biodiversity. They are further the main habitat of the moss *Tayloria rudolphiana* (Splachnaceae). *T. rudolphiana* is a priority species for nature conservation listed in the FFH -directive of the EU and in the Bern Convention. It has so far only been reported from the Alps and from a disjunct area in China. Despite the high conservation priority of *T. rudolphiana*, knowledge about its population structure, its habitat limitations and its dispersal- and establishment strategies are still very scarce.

Sycamore pastures, like many other old cultural landscapes, are threatened by ongoing land use changes such as management intensification at easily accessible sites as well as abandonment at more remote sites. Both processes may reduce the typical biodiversity associated with these landscapes, e.g. due to the clearance of trees and thus to decreased habitat size and connectivity.

In this study we specifically focus i) on describing and explaining the species richness of the epiphytes (bryophytes, lichens and vascular plants) on the sycamore trees and evaluating their nature conservation value, ii) on the effects of the trees on the ground vegetation of the pastures (bryophytes and vascular plants), iii) on the cultural history of Sycamore pastures (occurrence, spatial development and regional differences regarding the use of the sycamore trees) and iv) on the autecology of *T. rudolphiana*.

We will present the study design and some first results of this ongoing project.

P3 - Impact of the Extensification of Grassland on Grasshoppers (Saltatoria) and Wild Bees (Hymenoptera, Apiformes)

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North Rhine-Westphalia (cofunded by the EU) provides payments to farmers who subscribe to environmental commitments, i.e. no use of chemical fertilizer and pesticides. Most studies monitoring the effects of grassland extensification dealt with botanical parameters or bird communities. However, data on invertebrate communities are still missing. The aim of this research project is to analyse the effects of grassland extensification on grasshoppers and wild bees.

The investigations were conducted in 2013 and are being in 2014 on 24 grasslands of varying intensity (10 AEM, 10 RGL, 4 CNC) in the Eifel and the Süderbergland (NRW, Germany). The abundance of the species is recorded every three weeks from April to October along transects (250 m / 25 min). In addition, various habitat parameters are determined to characterize the landscapes.

In 2013, we recorded 297 bumblebees from 5 species and 568 grasshoppers from 15 species. The most dominant bee-species were *Bombus lucorum* (n = 109), *B. lapidarius* (n = 94) and *B. pascuorum* (n = 87). These are all euryoecious species. With increasing density of flowering plants, we observed an increase in the abundance of bees. This is mainly due to the large number of the long distance foraging *B. lucorum* and *B. lapidarius* that require an abundant offer of suitable flowering plants. However, the number of bee species also tends to increase on the extensively used grasslands. This effect is stronger in the Süderbergland than in the Eifel.

Most grasshopper-species (and the most thermophilic species, like *Stenobothrus lineatus*) occurred on the Contractual-Nature-Conservation Areas. The grasshopper communities of Agri-Environmental-Measure Areas show no significant difference to the ones of the reference areas. Here mainly euryoecious species like *Chorthippus parallelus* and *C. biguttulus* occur. Nevertheless, we found a rise in grasshopper-species with increasing diversity of flowers, which can be attributed to a more extensive land use.

The preliminary results indicate a minor influence of the Agri-Environmental-Measure on the composition of wild bee and grasshopper communities. Further studies will be conducted in 2014. Based on the results, suggestions on the evaluation and improvement of the Agri-Environmental-Measure "Extensification of Grassland" will be made.

P4 - Using a citizen science approach to assess the distribution and ecology of the invasive slug species *Arion vulgaris*

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As a consequence of globalization many different taxa are transported around the world in areas they never would have reached without human activity. Some of these taxa become invasive and can cause great ecological and economical damage both in native and agricultural/horticultural ecosystems. Here we focus on the ecology and the control of the invasive Spanish slug (*Arion vulgaris*), one of 100 most invasive species in Europe. This slug species causes considerable damage on crops, vegetables and ornamentals in agriculture/horticulture as well as in private gardens. Using a citizen science approach we assessed the abundance of *A. vulgaris* in gardens across Austria and correlated this with past and current rainfall patterns, air temperature, vegetation structure and diversity and earthworm activity. In this first year of the investigation 150 participants searched for slugs in their gardens or parks and fields. Therefore, a custom-made smartphone app based on the software EpiCollect/EpiCollect+ was created with which slug findings, surrounding vegetation structure, the earthworm activity and applied slug control measures on the site can

be reported. First results suggest that the relatively mild winter 2013/2014 had a positive effect on the slug populations in private gardens. Feedback questionnaires among participating citizen scientists showed that the awareness for invasive species and their relationships with abiotic and biotic parameters increased by taking part in this project. Preliminary results from this project indicate that a citizen science approach can be very promising when aiming to gain more insights on the distribution and ecology of invasive species while concurrently raising more awareness for the problem among a broader public.

P5 - Roadkill of European Hare in agricultural landscapes in Austria: comparing data collected by a citizen science project and by professionals

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The European hare (*Lepus europaeus*) lives in a variety of agriculturally managed landscapes that differ greatly in crop types, field size, landscape diversity and proportion of noncrop area. However, despite this flexibility the European hare has been in decline throughout Europe since the 1960s. One factor for this decline might be vehicle collisions: based on official data for the hunting season 2012/13, in Austria alone 24,279 hares were killed on roads (126,120 hares were shot). Overall, we expect the number of unreported roadkilled hares being considerably higher than the officially reported data. We hypothesize, that (I) the surrounding area influences the number of roadkilled hares and (II) roadkill data from citizen science projects and from professionals are convergent and complementary to official data. To test these hypotheses, we used data from a citizen science project (Projekt Roadkill) where participants report roadkill findings via a web application. This project is part of a new platform for citizen science projects in Austria (www.citizen-science.at). The data entry includes *inter alia* coordinates of the roadkill location, taxonomic information of the killed animals, when possible an image of the roadkill and some information about the participant's behaviour. Citizen science data were compared with those of another roadkill project that included reports by police and hunters. Both roadkill datasets were analysed regarding their surrounding landscape using satellite land cover data. Preliminary results suggest that many vehicle collisions with hares are not reported and therefore the combination of official data, citizen science and professional data collections seem to show a more accurate picture of the interactions between roadkills and landscape structure. Besides answering our research questions, findings of this project also allow the location of dangerous roadkill hotspots for animals and could be implemented in nature conservation actions.

P6 - Rabbits vs. songbirds: hyperpredation in farmlands

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Farmland birds have undergone a significant decline in agroecosystems. Nest predation is has been suggested as an important factor in the decline of farmland birds. In the Iberian Peninsula rabbits reach high densities in agriculture habitats, to the point to be considered an emerging pest. Rabbits may attract predators which may increase nest predation, a phenomenon known as hyperpredation. In this work, we evaluate nest predation in the context of intensively farmed olive orchards. We hypothesise that there may be a negative interaction between rabbits and many species of birds owing to their common predators. The proportion of nests predated was significantly lower in the tree nests (46%), whereas the predation rate in the ground nests was 62%. Rabbit abundance was additionally identified as a factor to affect nest predation since the highest rates of predation were located in areas of high rabbit abundance. Interestingly, we found a higher diversity of nest predators at lower rabbit density. This study suggests that conservation efforts as regards farmland birds should avoid areas with potential negative effects owing to the phenomenon of hyperpredation, as is the case of high rabbit abundances.

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P7 - Do bryophytes profit from agri-environmental schemes - A comparison of three ecological compensation measures in the Swiss lowlands

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Agricultural biodiversity has decreased substantially during the last few decades in Europe and globally. Agri-environmental schemes devised to promote sustainable farming have been a major policy instrument for the past decades to stop this negative trend. In Switzerland, these include ecological compensation measures (ECM), which are habitats subject to specific wildlife-friendly agricultural management. However, ECM were generally designed for the conservation of vascular plants and animals. The aim of this study was to investigate whether bryophytes typical of arable fields (specialists) occurred in sown wildflower strips, rotational fallows and improved field margins and how they responded to these ECM. In 30 studied fallows (12 wildflower strips, 12 improved field margins and 6 rotational fallows) in Northern Switzerland, we found in total 44 species with an average of 10.9 species per fallow. These included 13 arable specialist species and also some rare species (e.g. *Phaeoceros laevis*). We assessed the effects of fallow type, –quality and –age and selected environmental and vegetation parameters on bryophyte species richness with generalized linear mixed models. We show that bryophyte species richness is higher in 1-3 year old fallows than in fallows older than 3 years. Bryophyte species richness increases with higher percentages of open ground. Mean Landolt indicator values for nitrogen availability and pH significantly affect total bryophyte species richness. Arable specialist species richness is highest in rotational fallows, probably due to their relatively young age, and decreases with increasing cover of vascular plants. Bryophyte species composition was similar in the three fallow types. We conclude that the three studied fallow types are a suitable habitat for arable bryophytes and for arable specialist species. For the conservation of these organisms young fallows with a high percentage of open ground are most beneficial.

P8 - Hymenopteran parasitism and secondary endosymbiont infection of *S. avenae* in wheat fields in relation to fertilisation

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This project focusses on the interaction between aphids, their primary parasitoids and hyperparasitoids as well as secondary endosymbiont infection in winter wheat fields. In one part of this study it was investigated how these interactions and endosymbiont infection rates are affected by plant fertilisation as this may affect the biological control potential of aphids in cereals.

In 2013, aphids were sampled in fertilised and unfertilised plots in thirteen winter wheat fields at milk and dough ripening stage and screened for DNA of primary parasitoids, hyperparasitoids and three species of facultative endosymbionts.

In that year, all sampled aphids ($n > 7000$) were *Sitobion avenae* F. At the first sampling date (milk ripening stage) the endosymbiont species *Hamiltonella defensa* was the most frequently found secondary endosymbiont (42.3%), followed by *Regiella insecticola* (39.9%). Both endosymbionts simultaneously occurred only in 1.1% of the aphids tested while in 18.9% of them no endosymbiont DNA could be detected. Significantly more individuals of the red colour morph of *S. avenae* contained *H. defensa* than of the green colour morph. Fertilisation as well as aphid instar (adult or juvenile) had no significant effect of endosymbiont infection rates.

Parasitism rate ranged from 0 to 48% (mean: 7.8 ± 8.4) in the plots and did not differ significantly between the red and green colour morphs. Of the parasitised aphids 46.4% contained *H. defensa*, 33.7% *R. insecticola* and 0.8% both *H. defensa* and *R. insecticola*. Only 0.07% of the aphids sampled at milk ripening stage contained either hyperparasitoids and/or primary parasitoids, but this was true for 64.8% of the mummies. Of these, 31.3% belonged to *Dendrocercus* spp. As most of the hyperparasitoid species are mummy parasitoids, this result is reasonable. Additionally, a higher hyperparasitism rate is expected at the second sampling date later in the season due to more hyperparasitoids occurring in the fields.

Parasitism rate did not differ between fertilised and unfertilised plots at milk ripening stage. This result confirms the low sensibility of *S. avenae* to N-fertilisation (Hambäck et al. 2007), because aphids are thus adequate hosts for parasitoids under both fertilisation regimes.

Hambäck et al. 2007: doi: 10.1111/j.20007.030-1299.15800.x

P9 - Climate change induced precipitation patterns can affect epigeic arthropods in model agroecosystems with different soil types

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Climatic changes as prognosticated by the Intergovernmental Panel on Climate Change (IPCC) include altered precipitation regimes for eastern Central Europe with heavier rainfall events and extended intervals of drought periods during the vegetation period. So far, very little is known on how arthropods in agroecosystems cope with these altered patterns. Arthropods play very important roles in agroecosystems either as biocontrol agents or as pests. In order to study this, 18 experimental lysimeter plots were subjected either to long-term past precipitation patterns or to future rainfall patterns according to regionalisations of the IPCC 2007 climate change scenario for the years 2071-2100. Experimental plots were cropped with winter barley (*Hordeum vulgare*) and contained three different soil types (gleyic phaeozem, calcareous phaeozem and calcic chernozem). Between April and June 2013 we sampled and classified approximately 87,000 arthropod specimens using a custom-made garden vacuum.

Preliminary results indicate that rainfall patterns and/or soil types affect arthropods indirectly via changes in crop and/or weed structure and associated differences in the microclimate. We also tested whether rainfall patterns and/or soil types influence arthropod diversity and relationships between important barley pests such as aphids and white flies (Sternorrhyncha) or thrips (Thysanoptera) and antagonistic groups like carnivorous beetles (Coleoptera) or spiders (Araneae). Our provisional analyses suggest that climate change can affect arthropod abundance and ecological interactions between pestiferous and antagonistic arthropods and crop plants, however that different soil types might alter these interrelationships.

P10 - Pest control potential of web-building spiders in agricultural landscapes

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Web-building spiders are abundant generalist predators in arable fields that contribute to the suppression of economically important pests like aphids. The simplicity of agricultural landscapes can affect antagonistic interactions by acting on prey availability and diversity. Understanding trophic interactions in agricultural and semi-natural habitats which may act as a source habitat for pests is highly relevant particularly in organic farming systems that operate without pesticides. At three sampling dates between May and July 2013, we hand-collected web-building spiders with prey captured in their webs at six organically managed cereal fields and six semi-natural habitats (flowering fields) in Hesse, Germany. Study sites were located in simple or complex landscapes (quantified as the proportion of arable land in a 500 m radius). Surface-dwelling and on vegetation living arthropods were sampled with an insect suction sampler to estimate prey availability at each site. Preliminary results suggest that the overall percentage of aphids in spider webs increased in cereal fields during the growing season and capture rates may reflect population dynamics of aphids. The most abundant spider species, the cobweb weaver *Phylloneta impressa*, was a major predator of dipteran prey in semi-natural habitats, but primarily preyed on aphids in cereal fields. Additional results concerning the comparison between captured and available prey, food-web interactions and the impact of the surrounding landscape will be presented and discussed.

P11 - Herbicide roundup affects earthworm activity, reproduction and associated ecosystem functions

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Herbicide usage is increasing worldwide both in agriculture and private gardens, however our knowledge on potential side-effects of these pesticides on non-target soil organisms is scarce. Several studies showed little effects of glyphosate-based herbicides on compost worms (*Eisenia* spp.), however due to their life in litter layers these species will hardly get in contact with herbicides. To obtain a more realistic insight of potential side-effects of herbicides on earthworms that inhabit agroecosystems, we studied herbicide impacts on a vertically burrowing anecic (*Lumbricus terrestris* L.) and a soil dwelling endogeic earthworm species

(*Aporrectodea caliginosa* Savigny). In a full-factorial greenhouse experiment, we used large 50-litre mesocosms to test whether the herbicide spraying of a three-species plant community (grass, non-leguminous herb, leguminous herb) affects (i) earthworm activity (measured by surface cast production and moved toothpicks), (ii) earthworm reproduction (cocoon production and hatchability) and (iii) ecosystem functions (soil nutrient availability, decomposition rate, water infiltration). Herbicide application had different effects on the tested earthworm species: activity (cast production) of *L. terrestris* reached a peak during the herbicide application but was then significantly decreased; *A. caliginosa* showed little response to herbicide application. The number of earthworms hatching from cocoons was strongly reduced due to the herbicide application. Soil nitrate and phosphate availability was significantly enhanced, however decomposition and water infiltration little influenced by herbicide application. Given the broad use of these products these side-effects should be acknowledged when discussing tradeoffs between agricultural needs and ecological consequences.

P12 - Effect of pesticide cocktails of insecticides, fungicides and herbicides on non-target soil organisms and ecosystem functioning

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The application of a variety of pesticides (insecticides, fungicides, herbicides) is a common practice in modern-day agriculture. While such substances are widely applied, there is very little publically available knowledge about the effects of single pesticides and especially of combinations of different pesticides on non-target soil organisms. Some of these organisms can be essential in maintaining a variety of ecosystem services. The overall goal of this study was to examine the effects of seed coating of winter wheat (*Triticum aestivum* L.) with a neonicotinoid insecticide or a fungicide and a subsequent herbicide spraying on earthworms (activity and reproduction), soil microbes (respiration and biomass), soil decomposition (tea bag index) and slug herbivory. Investigations were conducted in a full-factorial greenhouse experiment using mesocosms filled with field soil (n = 5). Preliminary results indicate unprecedented effects of pesticide seed coating and subsequent herbicide application on non-target soil organisms with consequences for the functioning of these model ecosystems. Given the widespread use of these pesticides in agriculture non-target effects on soil organisms of single pesticide classes and combinations of different pesticides (pesticide cocktails) need more attention.

P13 - Distribution Pattern of Biogenic Macro pores along a Catena in the Hildesheimer Börde - Conventional Ploughing vs. Pedogenesis

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Size, number and distribution of biogenic pores are essential parameters for the soil water content. Infiltration and surface runoff are affected by characteristics of soil pores. Biogenic multiannual macro pores are formed by earthworms in particular. Thus, these pores accumulate in undisturbed soil, respectively under the plough sole.

To light the importance of pedogenesis for the site quality, seven soils on two differently cultivated areas of arable land were investigated along a soil catena. The measurement of biogenic macropores resulted by preparing three subgrades (each 1m²) in depths of five, twenty and forty cm.

Rendzinas of limestone were found on the upper slope. Colluvial influenced pararendzinas were allocated at the middle slope; the lower slope colluvial soil consisting of solum sediment on top of fossil chernozem developed from loess.

On both areas, the distribution of macro pores increases with increasing soil depth. This pattern results from mechanical tillaging of the land allowing the accumulation of biogenic macro pores solely below the plough sole. The number of macro pores is higher at the lower slope and decreases towards the upper slope. The cause of this is probably related to the quality of the habitat in terms of macro pores emerging fauna. This correlation is the significant factor. Deep, sub-humid locations with silt dominating soil type (lower slope) always show a higher number of biogenic macro pores than shallow and dry locations, where silt is rare (upper slope). The results display a decrease of biogenic macro pores correlating with the depth of ploughing. The relief position and the quality of location, dependent on the type of soil, are the major factors regarding the accumulation of biogenic macro pores.

P14 - A forgotten management method revisited: Can meadow irrigation optimize hay production and phytodiversity?

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Extensively managed grasslands in Central Europe are of high conservation value as they are habitat for many species and contribute to biodiversity. At the same time, these habitats are threatened by intensification, especially the use of mineral fertilizer. Before the invention of mineral fertilizer, meadow irrigation was a widely spread management method to increase grassland productivity. Today, only few areas exist where water meadows are still in use. One of these areas is the Queich valley near Landau (Palatinate), where many meadows have been continuously irrigated for the past hundreds of years. In our three-year research project, we hypothesize that this ancient technique could increase the nature conservation value of meadows without having to incur economic losses: We expect high phytodiversity and a reduction of the amount of fertilizer needed while quality and quantity of hay remain high. Here, organic matter content and activity of soil organisms could be important factors that contribute to the favorable conditions in water meadows. In the Queich valley, we investigate the effects of irrigation in contrast to fertilization on plant biodiversity, hay biomass and hay quality on 18 irrigated and 18 non-irrigated meadows with three levels of fertilizer applications. In our contribution we present results on the June harvest (hay biomass, mineral contents and composition) and phytodiversity alongside with data on the activity of soil organisms and soil parameters.

END OF SESSION 1

Session 2 - Targeting of farmland conservation

CHAIRS: MICHAEL STROHBACH, JENS DAUBER, SEBASTIAN KLIMEK

O1 - Optimizing agri-environment schemes for biodiversity, ecosystem services or both?

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The role of agri-environment schemes (AES) in protecting farmland biodiversity has been intensively studied during the last decade. Nevertheless, whether AES have been efficient is still debated, partly because AES often lead to yield reductions. Here we argue that AES should explicitly target species of conservation concern or ecosystem service providers, which would allow for an efficient spatial allocation of conservation and ecosystem service schemes. We construct a simplistic, conceptual model, based on well-founded ecological principles, to illustrate how to allocate biodiversity conservation schemes and ecosystem service schemes spatially, depending on where they are needed in order to meet the goals of protecting biodiversity per se and promoting environmentally sustainable agriculture. The best allocation depends on productivity and opportunity costs of conservation, which are higher in productive landscape as compared to less productive ones. Given yield constraints, the share of non-crop land would need to be decreased in productive landscapes, but assuming ecosystem service paybacks to agricultural yields the loss of non-crop habitat needs to be compensated for by within-field AES.

Importantly, the separate goals of biodiversity conservation versus service provisioning imply that the efficacy of AES should be evaluated at different spatial scales. A full evaluation of the conservation benefits of AES needs to consider large spatial scales, since plot-scale biodiversity measures are not additive. Regarding ecosystem service provisioning we need to evaluate AES on smaller scales and improve our understanding of the functional importance of AES in order to develop more efficient schemes. This will require (1) a focus on mechanistic factors regulating populations of ecosystem service providers, and (2) ecological-economic modelling by e.g. spatially explicit production functions integrating the payback of intermediate ecosystem services to agricultural yields.

O2 - Collaborative agri-environment schemes could benefit biodiversity and ecosystem services, but will farmers be willing to participate?

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The primary aim of many agri-environment schemes (AES) is to enhance biodiversity; however, the results of AES designed for this purpose have to date been largely underwhelming. One reason for this may be because AES tend to be administered at the farm-scale. The results of the work outlined in this talk indicate that collaborative AES (cAES) – single environmental management agreements for multiple farm units – can not only benefit biodiversity but are relatively attractive to farmers. We go on to discuss how a shift to this type of scheme may impact upon ecosystem services (ES).

Evidence gathered from studies carried out across European farmland demonstrated that more than a third (18 of 52; 35%) of the bird, mammal, reptile, amphibian and bumblebee species important in English farmland operate at scales larger than the typical English farm (146 ha) in the breeding season. While this study relates ranging behaviour specifically to England and the English AES system, the estimates of ranging behaviour presented in this study could also be used (with caution) to compare with farm sizes elsewhere in Europe, making the results of wider geographical relevance.

Data were obtained from interviews with 32 farmers with differing AES backgrounds (participants in either low or high level schemes, and non-participants). 81% of interviewees were found to be willing, in principle, to participate in a collaborative AES (cAES) programme. However, they viewed less extensive options (e.g. management of existing hedgerows) more favourably than extensive or cooperatively demanding land management options (e.g. large-scale habitat creation). Data from an online consultation of a further 122 farmers supported the principal finding, with 75% of respondents willing, in theory, to participate in collaborative schemes.

We conclude that well-designed landscape-scale schemes are likely to be more beneficial than farm-scale schemes for a small but significant number of key farmland species, including bats, mammals and some important pollinators, while unlikely to harm species operating at smaller scales. These schemes can be expected to attract widespread participation from landowners. Thus, policymakers may be heartened that collaborative AES are a potential multifaceted solution to environmental management on farmland.

O3 - An ecological-economic modeling procedure and a decision support tool for cost-effective agri-environment schemes to conserve grassland biodiversity

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In developed countries each year a substantial amount of money is spent on agri-environment schemes (AES) which compensate farmers for carrying out land use measures which are costly to them but beneficial for biodiversity. We present an ecological-economic modeling procedure and a decision support tool (called DSS-Ecopay) to design cost-effective AES to conserve grassland biodiversity. The modelling procedure is novel in two ways: First, it comprehensively addresses challenges relevant to AES design. It covers a wide range of endangered species and grassland types (13 bird species, 14 butterfly species and 7 grassland types), includes many (altogether 475) different land use measures, takes into account that the opportunity costs of these measures spatially differ as well as their effects on the species and grassland types, and can be applied on a large spatial scale. Second, the modeling procedure explicitly considers the different costs of the timings of the land use measure as well as the impact of the timings on the different species and grassland types. We demonstrate the power of the modeling procedure and DSS-Ecopay by evaluating the effectiveness and cost-effectiveness of an existing grassland AES in Saxony, Germany.

O4 - Effective implementation and evaluation of agri-environmental measures in Lithuania: The role of result-based remuneration of biodiversity protection

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The Landscape Stewardship Scheme is one of the four main agri-environmental schemes implemented in the Lithuanian rural development programme and has a broad array of objectives including maintaining natural and semi-natural meadows and wetlands. The scheme offers a menu of different activities farmers can sign up for. Activities are targeted at the protection and improvement of biodiversity on natural and semi-natural meadows and makes particular reference to endangered communities of plants, ground-breeding wild bird populations, and insects. However, the efficiency and environmental targeting of the scheme is widely criticized and the uptake by farmers is very low. An effective evaluation of the impacts of the biodiversity payment is in particular hampered by a lack of suitable biodiversity indicators and monitoring data. Improved environmental targeting and the integration of environmental monitoring into the scheme design are key

characteristics of result-based remuneration of biodiversity protection. The potential of result-based remuneration to increase the effectiveness of standard action-based agri-environmental measures (AEMs) has generated increased interest in Europe. A number of examples are or have been tested and implemented in Austria, France, Germany, Ireland, Netherlands, Sweden, Switzerland and the UK. The implementation of result-based biodiversity payments in German and French rural development programmes has shown that this approach is generally conforming to the current institutional framework of the second pillar of the CAP.

The main objectives of the paper are to synthesize the main factors constraining the effectiveness of the Landscape Stewardship Scheme, to review the strengths and weaknesses of result-based biodiversity remuneration and to derive recommendations for an effective implementation and evaluation of agri-environmental measures targeted at promoting biodiversity protection on farmland in Lithuania. The paper will largely build on the results of the assessment of new evaluation frameworks of biodiversity impacts and existing examples of result-based remuneration of biodiversity protection in Europe as well as stakeholder consultations carried out in the EU-funded BALTIC COMPASS and ENVIEVAL projects.

O5 - From indication to conservation: targeting conservation actions at High Nature Value farming

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Twenty years ago, the concept of High Nature Value (HNV) farming was developed in order to call attention to the declining species-rich farmland of Europe. Today, the maintenance of HNV farming is a clear policy priority for the EU and is essential for achieving the objectives of the EU Biodiversity Strategy 2020. However, despite being a priority within the Rural Development Programmes, little progress has been made at targeting conservation measures at HNV farmland and farming systems. This is mainly because HNV farming systems are hard to characterize and localize, and efforts to do so have been hampered by the limited availability of data that are of sufficient spatial and temporal resolution. Here we (1) revise current approaches for localizing and characterizing HNV farming and outline a synthesis of approaches; (2) we further analyze how HNV farming is related to existing concepts aimed at biodiversity conservation, and which EU policy instruments could help preserve them; (3) based on this analysis, we make suggestions for how the concept could be developed to its full potential so that HNV farming remains an integral component of our modern agricultural landscape.

O6 - Cost-effectiveness and benefits of on-farm “green infrastructure” water-management options versus a large reservoir in the Warta-region, Poland

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Despite secure European Union funding for a dam construction in the Warta region, Poland, implementation has been dragging its feet. Public reservations towards large engineering measures – “grey infrastructure” – to manage the flood and drought risks have been increasing. The hope is that switching from “grey” to “green infrastructure” in drought and flood risk management is not only possible and socially more acceptable, but also has significant co-benefits for the environment. This paper compares the cost effectiveness and benefits of a large reservoir versus three on-farm, “green infrastructure” options to manage floods and droughts in the Warta region, Poland: small ponds, shelterbelts and conservation tillage.

We consulted stakeholders of the Warta region and calculated the investment and maintenance costs in terms of €m⁻³ water stored or annual runoff reduced for four different strategies: large reservoirs, small ponds, shelterbelts, and switching to conservation tillage. The most cost effective measure for reducing runoff was switching to conservation tillage practices, because this switch reduces machinery, fuel and labour costs in addition to reducing water runoff. Although shelterbelts that reduce annual runoff cannot be directly compared to ponds and reservoirs that store water, our estimates show that they likely compare favourably as a natural water retention measure, especially when taking account of their co-benefits in terms of erosion control, biodiversity and pollination. Small ponds are two orders of magnitude more costly than large reservoirs (demonstrating an economy of scale), however they offer co-benefits that should be considered, including especially the value of small ponds in promoting corridors for migration. Our estimates indicate that green infrastructure could indeed be an effective alternative to traditional large reservoirs for water management, with attractive co-benefits for people and biodiversity. Finding the right mixture of management options requires two parallel steps: (1) refining the cost-effectiveness for this particular place, and (2) an extended transdisciplinary process with scientists and stakeholders from the region.

O7 - Modelling the impact of farming systems on field habitats at the regional level

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Agricultural practice is one of the most important pressure factors for biodiversity loss. Policy answers to this problem encompass target setting for the share of biodiversity friendly agriculture, incentives for agri-environmental measures and monitoring of success. However, efficiently targeting, implementing and monitoring of agri-environmental policies are supported most effectively by comparable and standardized evaluation results at the regional level. Unfortunately, regional data about species and habitats is usually not sufficiently allowing for quantitative and comparable results. However, impacts of agricultural practices on biodiversity cannot be analysed and evaluated merely depending on individual cases. Models which could fill this gap are very scarce. In particular, state and pressure indicators are lacking for modelling species richness on agricultural fields and, subsequently, for modelling the consequences of changing pressures.

We present a model for evaluating the nature conservation value of field habitats based on flora species richness. Respective key indicators of the model are the farming system, soil conditions, and landscape heterogeneity. The model was applied in a case study to test for the effects of the agri-environmental measure 'organic farming' on flora species richness and the associated nature conservation value of field habitats.

The results of the case study reveal that the model could help to identify priority areas for specific farming systems. Outcomes are also suitable for inventory and assessment of profits and losses from agro-ecosystem changes within the framework of ecosystem services and might ease the communication of agricultural effects to policy makers.

O8 - Maintaining granivores in agroecosystems for biological weed control

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Granivores can consume considerable amounts of weed seeds in agroecosystems. For example, estimates of annual weed seed losses due to granivores range from approx. 20 to 90%. As most weed species are obligate annuals with a persistent seed bank, a yearly reduction in seed input will result in a lower seedbank density and eventually in lower plant densities. Maintaining and stimulating granivore

populations will help to enhance agroecosystems resilience by largely controlling weed populations biologically.

The most important groups of granivorous animals on arable land are birds, rodents, carabid beetles, ants and crickets. They differ hugely in habit requirements, operate on different spatial scales, and differ with regard to the main foraging period and amount and type of seeds that they consume. Consequently, the identity of the granivore group(s) at a location may determine the success of biological weed control, i.e., their impact on weed population growth and weed species composition.

Knowledge on the spatial distribution of most groups of granivores is sparse, because most of these species have seldom been sampled systematically. Some locations seem to harbour multiple groups of granivores simultaneous, while others seem to be void of granivores. Some groups of granivores seem to occur regionally only. In general, very little is known with regard to the factors that influence granivore occurrence, density and activity. It is even unknown whether the current distribution is the result of natural or anthropogenic constraints. Anthropogenic constraints could be interesting, because they may hold the key to reintroducing locally extinct granivores.

In recent years, more and more knowledge on granivores in agroecosystems is being generated. A brief overview of this information and examples of natural and anthropogenic constraints on granivore populations will be presented. The main knowledge gaps will be addressed and prospects for habitat management will be offered.

P1 - The impact of functional biodiversity on arable weeds; determining the degree of seed limitation

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In this study, the degree of seed- or microsite-limitation in weed populations in arable fields will be determined. It is generally assumed that annual weeds in arable fields are restricted in population growth by the amount of seeds they produce; this is in contrast to other habitats where populations face constraints in growth by the limited availability of microsites. Each plant population in a certain habitat is somewhere between 100% seed- and 100% microsite-limited. There is little experimental evidence to the degree of microsite limitation of an annual arable weed. In the case a weed population is (mainly) seed-limited this opens the possibility to control weed populations by targeting the seed stage rather than the seedling. One cause of weed seed removal is the in-field predation by animals, such as insects and rodents. The experiment will measure the effect of weed seed

predation on the one hand, and the effect of interspecific competition, induced by the selective use of herbicides, on the other hand. The experiment, which started in the summer of 2013 consists of six plots of 13.5 m by 10.5 m in each of two fields. Within these plots there are 12 subplots, 1.5 m by 1.5 m, half of which are surrounded by a plastic enclosure that prevents carabid beetles and rodents from getting in; the other six allow free access to all predators. Subplots were seeded with *Echinochloa crus-galli* (L.) P. B. at rates of 0, 300, 600, 1200 or 2400 seeds per m². There are two levels of competition by treating one half of the plots with a selective herbicide such that no other weeds than *E. crus-galli* were present. On the other half, herbicide use was tuned to a level that allows a certain density of other weeds, to compete with *E. crus-galli*, thus limiting the amount of available microsites. Dispersal of newly produced seeds will be prevented so that the fate of a single well-defined population of seeds can be monitored over three vegetation periods. We will compare the cumulative number of seedlings and reproductive plants after one season with the corresponding population numbers after three years. The way in which the results differ between the sown seed densities will give us an impression on the degree of seed-limitation in the weed population.

P2 - The importance of post-dispersal seed predation in the population dynamics of the weed *Echinochloa crus-galli* in maize

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Field experiments are being conducted to investigate the potential of weed seed predators to lower the population density of *Echinochloa crus-galli* (L.) P. Beauv. in two minimally tilled maize fields in North-Eastern Germany. The fate of a single seed cohort of *E. crus-galli*, sown at different densities, will be followed in the presence and absence of post-dispersal seed predators and in the presence and absence of interspecific competition. In contrast to herbicides, which target seedlings, post-dispersal seed predators target newly produced seeds. Over the course of three years, important weed demographic rates will be estimated, namely the number of seeds in the spring seedbank, seedling recruitment, plant survival, fecundity and viability of new produced seeds. These will be used to parameterize a population model of *E. crus-galli* in maize. Weed population dynamics in the presence and absence of seed predators and, similarly, in the presence and absence of interspecific competition will be compared. The results of this experiment will determine whether post-dispersal seed predation can lower weed densities and should, therefore, be considered an important ecosystems service. If so, it would be worthwhile to invest in maintaining and enhancing of post dispersal seed predators.

END OF SESSION 2

Session 3 - Farmland bird ecology

CHAIRS: PÉTER BATÁRY, RIHO MARJA

O1 - Grassland winners and arable land losers: how did the past land use changes affect farmland birds in the Czech Republic?

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Farming practices underwent a rapid dynamics in Eastern Europe during last two decades. Agricultural intensity dropped after the fall communism in 1990s resulting in large-scale land abandonment. More recently, agri-environmental schemes became available due to entering of Eastern European countries the European Union. We studied how these socioeconomic changes mirrored in farmland bird population trends and community composition in the Czech Republic. We found that after 1990 the intensity of agriculture declined mainly in marginal agricultural regions at higher altitudes where the arable fields were replaced by grasslands, but the intensity remained high in the most productive lowland regions. To elucidate the response of farmland birds to these land use changes (i) we performed an extensive bird survey using following pairs of plots: one plot on grassland established recently on a former cereal field, second plot on a cereal field. (ii) We analysed data from a common bird monitoring scheme covering the periods before (1980s) and after (1990s and 2000s) major agricultural changes took place. We found that the arable land-grassland conversion is an important factor significantly altering bird community composition. Several species were present solely on the plots of arable land (e.g. *Perdix perdix*), or on the grassland plots (e.g. *Saxicola rubetra*), while other species (e.g. *Alauda arvensis* or *Emberiza citrinella*) did not discriminate between the two habitat types. These local habitat associations predicted species' population trends at the country level. Species associated with grasslands increased or did not change their population status, while the arable land species declined. Regional-specific analysis showed that these declines were observed both in lowlands and higher altitudes. This suggests that both land abandonment in marginal regions, and high agricultural intensity in the most productive regions, are threatening farmland birds in the Czech Republic.

O2- Bad, and still worsening: status of (and threats to) farmland birds in Italy

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86% of the farmland bird species in Italy are currently in an unfavourable conservation status (inadequate or bad). The condition of species tied to grassland-

like habitats (permanent grassland, pasture, pseudosteppe) is particularly concerning: none has a favourable conservation status, and most have bad status. The dramatic reduction of permanent grassland and pastures, due to both abandonment and conversion into other uses, coupled with the unsustainable management of large parts of the remaining grasslands, are likely the main determinants of such a negative condition.

Shrike species declined by 30-95% in the last 10-30 years; also most larks, sparrows and warblers showed marked declines. Only some generalist species (particularly corvids and starlings) currently have a favourable conservation status.

Considering all the available information on the ecological requirements and the demographic trends in Italy of some model/indicator species belonging to several bird families, we try to assess the major threats to farmland species, and the caveats of the rural development programmes implemented until now (including agri-environmental schemes). We then propose possible measures for future programmes and agri-environmental schemes, targeted at conserving or improving suitable habitats and conditions for farmland bird species, on the basis of their ecological needs.

Studies suggest that both land abandonment and agricultural intensification have significantly impacted over farmland birds, and are still threatening several species, which lose their own habitat (also because of a sinergic effect of climate change) or are unable to adapt to the new agricultural practices. Some measures proposed to contrast land abandonment have resulted in increased intensification (especially in the Alps), with dramatic consequences for species sensitive to grassland management.

O3 - The effects of ground vegetation in vineyards on the habitat use of Woodlarks *Lullula arborea* and their invertebrate prey

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Vineyards are among the most intensively managed crop systems in Switzerland with up to 95% of the surface showing no ground vegetation cover. However, there has been a considerable reduction in the application of herbicides over the past decades, leading to more vegetation of higher diversity on the ground. These different management types lead to a fragmented mosaic of few parcels with ground vegetation surrounded by parcels with bare ground only and create a favourable habitat for the endangered ground-nesting woodlark *Lullula arborea*. We investigated its habitat preferences in relation to vineyard characteristics using the combination of radio-tracking data, field surveys and satellite image derived NDVI values. Within their territories woodlarks preferred larger, greener and more connected parcels with a higher plant diversity and higher arthropod abundance

and richness. Our results further indicate that the optimal feeding habitat is a small-scaled mosaic incorporating around 50% ground vegetation and 50% bare ground, which optimizes food abundance and simultaneously its availability. On a landscape scale, woodlarks selected territories with a higher amount of ground vegetation compared to the surroundings. Our findings demonstrate that the vineyard management directly impedes the abundance and richness of arthropods, and indicate that woodlarks adjust their habitat use in relation to the availability and abundance of its prey. Using these findings, our project aims to give clear recommendations to winegrowers about the amount, distribution and connectivity of parcels with ground vegetation within the vineyards, which should ultimately favour biodiversity in general and woodlarks in particular.

O4 - Hedges and ground covers: their effects on songbird communities in a Mediterranean agroecosystem

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The simplification and homogenization of agricultural landscapes has led to dramatic losses of farmland biodiversity. Increased nest predation might be one of the mechanisms contributing to the decline of passerine populations. Ground covers are agri-environment measures aimed at halting biodiversity loss by creating high quality habitat patches embedded in a homogeneous landscape. However, they may act as ecological traps since they are preferred by breeding birds, but they could attract predators as well. To investigate nest predation rates in olive orchards with and without green covers, we performed nest predation experiments with artificial nests. The experiments were completed during the breeding season in 2013, in two areas of southern Spain. Each artificial nest (n=450) was placed on the ground or on an olive tree, and contained three Quail *Coturnix coturnix* eggs, one stuffed with plaster and two natural eggs. Ground nests were significantly more predated, irrespective of the presence of ground covers; tree nests were less predated in areas with ground cover. There was a clear separation of predator faunas between ground and tree nests, as identified from marks in plaster eggs and by photo-trapping. Rodents were the most frequent predators of tree nests and the lower predation rates in orchards with ground cover, is probably linked to a change in the foraging behavior of rodents. Moreover, in this more complex habitat rodent populations might be limited by their predators (Mustelids). This study underscores the important role of agricultural practices in preserving farmland bird communities, particularly tree-nesting species, suggesting that for this group, orchards with ground covers might not act as 'ecological traps'.

O5 - Effect of agri-environmental management on the foraging behaviour, diet and reproductive success of a declining farmland bird

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To counteract biodiversity loss in agricultural areas, agri-environmental schemes have been established in many European countries. One widely adopted management option are arable field margins: strips of land where no manure or pesticides are being applied, mostly sown with grasses and herbs. We studied how effective arable field margins were in supporting a skylark population in the northeast of the Netherlands. In the research area, field margins had been established for over 12 years with a surface area of around 5%. Nevertheless, the skylark population decreased with 40% between 2007 and 2012. Field margins contained more food than agricultural land and were highly favoured as a foraging habitat. The diet of young skylarks that were provided with food from field margins was more diverse. However, field margin availability did not improve the body weight of nestlings, nor did it improve breeding success. The presumably more subtle effects of increased food availability could not compensate for the high nest failure rates resulting from agricultural operations, mainly silage cutting of grasslands, and predation. In this area and similar areas, the provisioning of safe nesting habitat throughout the breeding season is essential to improve breeding performance and maintain populations. Our research suggests this can be achieved by reducing the frequency of silage cuts on grassland and by increasing the surface area of lucerne, a crop with good nest survival rates and relatively high food abundance.

O6 - Maintaining bird diversity in a traditional farming landscape in Eastern Europe

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Many traditional farming landscapes harbor high biodiversity worldwide, but this is increasingly threatened by land use change. Farmland biodiversity is threatened (1) by agricultural intensification, associated with a loss of woody vegetation cover and landscape homogenization; and (2) land abandonment, associated with the transition of farmland into shrubland. To appropriately target conservation measures that mitigate these threats, it is important to understand the drivers of

biodiversity in traditional farming landscapes. We present a natural experiment on bird community responses to landscape structure in Transylvania, Romania. Repeated point counts for breeding birds were conducted in a randomly selected set of 30 forest, 60 grassland, and 60 arable sites, which spanned stratified gradients in heterogeneity and woody vegetation cover. We examined the responses of species composition, species richness, and richness within functional groups, to woody vegetation cover, landscape heterogeneity, and topography (each measured at local, context, and landscape scales). Species composition in forests differed from that in grassland and arable land. Species composition in grassland and arable land responded to gradients of woody vegetation cover at all three scales. Within grassland and arable land, total species richness, richness of hedgerow farmland birds, and forest specialists asymptotically increased with local-scale woody vegetation cover. In contrast, richness of open-country specialists responded negatively to context-scale woody vegetation cover, and hedgerow farmland birds responded negatively to landscape-scale woody vegetation cover. Thus, both land abandonment and land-use intensification are likely to reduce bird diversity, although different groups of birds would be impacted by different future land-use change scenarios. Farmland bird communities would benefit from policies mitigating land abandonment or land use intensification, while actively maintaining gradients in woody vegetation cover and heterogeneity across multiple scales. This could be achieved by encouraging for example, the maintenance of a diversity of field margins in arable land prone to intensification and continued low-intensity use of extensive grassland areas prone to land abandonment.

O7 -Who wants to be a “farmland bird”- On the importance of farmland for migrating birds

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The negative population trends of farmland bird species due to changes in agricultural management are frequently discussed and studied. Farmland birds as a group are also commonly used as indicators when evaluating sustainable agriculture, land-use changes, farm management or agricultural policies at both national and EU level. However, only a limited number of bird species that are highly dependent on farmland habitats during the breeding season are considered as “farmland birds”, whereas very little attention has been paid to birds using farmland as stopover habitat during migration (except for geese and other potentially crop-damaging species). Thus, potential effects of modern agriculture on these species are hardly known. We use bird census data from organic and conventional farms in two different landscape types (intensively open plains and small-scale mixed farming landscapes) to extrapolate the total number of migrants

using farmland in Sweden's southernmost province, Scania. Based on the assumption of an average turn-over rate of seven days, at least 14.7 million birds (about 5% of the Swedish and Finnish breeding bird populations) are estimated to use farmland in Scania during the autumn migratory season. We also show that these birds have clear preferences for certain farming practices and landscape types. Discussing these results in relation to Scandinavian breeding populations and records from known staging sites of international importance according to the Ramsar Convention, it becomes clear that farmland habitats play an important role during the migration of many birds and species. Given the negative effects of agricultural intensification on birds breeding and wintering in farmland, and the known impact that other factors, such as climate change, on migratory birds, there is an ample need to also consider migrants when evaluating farming effects on bird populations.

O8 - Which agri-environment scheme favor in Estonia on farmland bird species richness?

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Farmland biodiversity, including farmland birds, has been declining significantly during the past decades in Europe. Agri-environment schemes (AES) were introduced in the late 1980s in European Union countries as a solution to combat biodiversity decline. We examined the effectiveness of AES in Estonia for farmland bird species richness, abundance and species composition over a period of 2010–2012. We compared bird variables of two major types of farms with AES contracts, the organic farming and the less strict environmentally friendly farming with biodiversity on conventional farms in two regions of Estonia (Central and South). The two selected regions differ from each other in landscape structure, soil types and crop yields. Bird species richness profited only from organic farms compared to conventional and even to environmentally friendly farms. In general, both mixed modelling and redundancy analysis indicated that landscape effects were stronger than management effects. Bird species richness and abundance were significantly higher in the heterogeneous landscapes of the Southern than in the homogeneous landscapes of the Central Estonia. Our findings demonstrate that only organic farming favours farmland birds in Estonia but not the environmentally-friendly management. So, the results suggest that in addition to organic farming further maintenance of a heterogeneous landscape structure greatly contributes to

farmland birds.

P1 - One shrub is not like another: A knowledge-based suitability model in hedge birds

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Hedges are known to be important habitats for bird populations in agro-ecosystems. In conservation and landscape planning bird diversity is often used as indicator for biodiversity and landscape quality. Ecological habitat models, calculated with presence-absence data, are a common method to make predictions on bird distributions or population developments. However, knowledge-based habitat suitability models provide an alternative model type, particularly if data on distribution and abundance of species are not available. In contrast, scientific knowledge on the requirements of different species has been acquired during recent decades and is thus available for a broad range of species. Here, we utilized information of bird-hedge associations as indicated by the peer-reviewed literature for 25 bird species, i.e. the Red-backed Shrike or the Yellowhammer. With this information we modeled habitat suitability of hedges and woody structures using mappings on hedge structures and features in an agricultural landscape in the county of Vogelsberg (Hesse, Germany). In addition, we conducted a field survey on birds inhabiting the modeled hedges in the study area to assess model quality as empirical validation, which is often criticized when models are transferred into nature conservation practice. Our results show that it is possible to specify and estimate requirements of species groups or single species in hedge structures and features from peer-reviewed literature. However, several restrictions were given, i.e. lack of information for some species or difficulties in data translation from different references. Considering the importance of hedges as linear landscape structures for biodiversity and landscape quality in agro-ecosystems, mapping their ecological associations is an important prerequisite for hedge management, particularly prior to cutting of hedges. Knowledge-based models can provide an efficient way to predict habitat suitability for hedge birds for further conservation management.

P2 - Farmland bird abundance in Central Germany: trend analysis based on species traits and land use

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The TERENO initiative (TERrestrial Environmental Observatoria; www.tereno.net) of the Helmholtz Association is aiming at long-term data sets covering abiotic and biotic parameters. This unique large-scale project aims to catalogue the long term ecological, social and economic impact of global change at the regional level. One focus of the Helmholtz Centre for Environmental Research is on birds in agricultural dominated landscapes within the Harz/Central German Lowland Observatory in Central Germany. Within an area of 50 x 90 km in Saxony-Anhalt farmland birds were monitored at six sites of each 4 x 4 km following the point-stop count method (20 points per site). Data have been collected in 2001, 2009, 2012, 2013 and 2014. We combine bird abundance data with species traits, land use, landscape composition and configuration to explain the changes in abundance of different ecological groups.

END OF SESSION 3

Session 4 - Synthesis in Biodiversity

CHAIRS: HENRIQUE M. PEREIRA, OLIVER PURSCHKE, REBECCA THIER-LANGE, MARTEN WINTER

O1 - Patterns of Local Species Richness in a Tropical Forest

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In the last decades, detailed long-term data about tropical forests has become available.

Yet, due to the complexity of these ecosystems, the governing processes shaping these forests still are unclear. By applying a local, grid-based analysis to data from a tropical forest in Panama, we show that there are distinct and discernible patterns in the structure and the dynamics of this forest and that there are strong relationships between important characteristics like abundance, species number and their development over time.

We compare this field-data to a null-model and discuss our findings in the light of Mac-Arthur's Island Theory as well as Hubbel's Neutral Theory.

O2 - Do more diverse forests have lower mortality? A test of the insurance hypothesis using a global network of tree diversity experiments

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Forests provide key ecosystem services to humans including wood production, fresh water supply, and carbon sequestration. The insurance hypothesis suggests that more diverse forests are more effective at supplying these ecosystem services, because they are more stable over time and more resistant and resilient to global change. However there is still a lack of evidence for this relationship in forests,

particularly from experiments specifically designed to test the effect of tree diversity on forest functions. One component of the insurance effect is the prediction that diverse communities should establish better over a range of environmental conditions because they have reduced variation in tree mortality during the early years. If mortality rates vary between species then monocultures of susceptible species might fail to establish consistently. Mixed plantings that combine species with different mortality rates will reduce this risk since species with lower mortality rates can compensate for others with higher rates. We tested this theory using a worldwide network of field experiments with trees specifically designed to estimate the impact of tree diversity on forest functioning and stability (TreeDivNet: www.treedivnet.ugent.be). These experiments contain plots differing in species richness and with various randomly selected tree species compositions. The length of the species richness gradient varies between experiments, but all have monocultures of each species. We assembled a database of the survival of young trees from 17 experiments located in 12 countries on five continents, encompassing a variety of boreal, temperate, and tropical biomes. We conducted a meta-analysis of tree survival to test the insurance effect of tree diversity. Preliminary results reveal some interesting trends: an overall effect size that is slightly positive and a significant effect of diversity only observed in mixtures of at least four species. We discuss the challenges in harmonizing individual datasets into a global one and the methods used for this synthesis (effect sizes, statistical techniques). Furthermore, we discuss the potential for the synthesis of results from TreeDivNet experiment to offer valuable insights into establishing plantations and restoring forests.

O3 - Niche and fitness differences determine the imprint of evolutionary relatedness on species' coexistence in a diverse tropical forest

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Theory predicts that coexistence of competing species will depend on the balance between their niche and fitness differences, and that based on such balance, competitive exclusion may leave opposing signatures on phylogenetic relatedness of coexisting species. We integrate demographic and phylogenetic approaches to provide the first test, in a natural and highly diverse system, of two major predictions from recent coexistence theory. For the entire community of > 200 tree species in a 50-ha tropical forest plot in Panama, we tested whether species' co-occurrence was better explained by their evolutionary relatedness or by species

niche and fitness differences derived from species-specific models of light dependence of demographic rates. Finally, we tested whether the effect of evolutionary relatedness on coexistence was determined by species' niche and fitness differences. Species co-occurrence was not associated with phylogenetic distance, but instead could be explained by niche and fitness differences: species were more likely to coexist when niche differences exceeded fitness differences. Despite strong phylogenetic signal in niche and fitness traits, phylogenetic distance was not directly explained by either fitness or niche differences but instead by their interaction effect – while distantly related species co-occurred more often, species pairs that were less likely to coexist could either be closely or distantly related depending on fitness and niche differences. Our study supports predictions from contemporary coexistence theory that have not been tested previously in species rich systems. The results provide a possible explanation for the lack of correlation between competition and phylogenetic relatedness in existing studies and suggest that the effect of evolutionary relatedness on coexistence is likely determined by species' niche and fitness differences.

O4 - Beyond phylogenetic diversity: explicitly incorporating evolutionary history within communities into diversity measure

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Diversity has long been considered an important property of biotic communities. More particularly, phylogenetic diversity has recently been shown to be an

important community property that may be related to ecosystem function or biotic interaction for instance. Numerous measures of phylogenetic diversity have, therefore, been developed. However, each of these phylogenetic diversity metrics only accounts for a small amount of the overall information of species relatedness patterns within a community and hence, some communities with particular phylogenetic patterns could not be easily represented or differentiated from others with existing measures of phylogenetic diversity. We developed a way to more completely quantify the relatedness patterns within communities by fitting estimator functions through the lineage through time (LTT) plots that represent a given community. We found that these communities with particular phylogenetic patterns can be better differentiated with parameters from the LTT estimations. The correlation between standard measures of phylogenetic diversity and parameters from the LTT estimations showed that they do not carry the same information. A fuller characterization of relatedness patterns within biotic communities may be useful, and LTT estimators may provide a relatively straightforward way of doing this.

O5 - Evaluating the spatial influence on gap-filling of global plant functional traits

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Plant traits are thought to be closely linked to ecosystem functioning, i.e. they serve as intermediates for matter and energy fluxes between the atmosphere, hydrosphere and pedosphere. The biggest plant trait data base TRY allows global multivariate analyses - in combination with the gap-filling tool called Hierarchical Probabilistic Matrix Factorization (HPMF).

HPMF assumes that plants react with all their individual traits conjoined due to environment driven trade-offs on a whole plant level. Understanding of these relationships can bring about an understanding of functional diversities' role for ecosystem functioning.

HPMF derives information from between and within- plant traits, but additionally also from plants' taxonomic information. This approximated phylogenetic proximity is used as physiological similarity, also. HPMFs' dependency on taxonomic information can, however, potentially lead to uncertainties or biases when using it for certain data subsets only.

To test for spatial biases we performed a sensitivity analysis. The original global data set had 78000 geo-referenced observations on an individual level for 12 plant traits. Two different subsets were chosen: 1) European data, which contributes the

majority (59598) and 2) the relatively small fraction of the Rainfor data base for tropical regions (1445).

Firstly both subsets of data were added with differently sized extra gaps. These were not known to the algorithm HPMF. Then the HPMF script predicted all gaps for the subsets from the subsets. This run was repeated with exactly the same gaps, yet this time the algorithm could harvest information from the whole global geo-referenced data.

The results of HPMF got evaluated by calculating the RMSE in two different ways: 1. of the cross-validated data within the HPMF script and 2. for the extra gaps in the subsets of different size only.

The results show the effect of data origin, size and the contribution of additional global data. One can expect an increase of precision when global data is added to the subsets in comparison likewise to a decrease for gap size. The effect is expected to be greater for Rainfor data than for the European data.

O6 - Pervasive effects of exotic earthworm invasion on the biodiversity of North American forests: a meta-analysis

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Across forest ecosystems in North America, exotic earthworm invasion has profoundly altered a multitude of ecological processes. While exotic earthworms have often been found to reduce plant and soil invertebrate diversity, the magnitude of these effects varies considerably. Here, our objective was to synthesize the effects of exotic earthworm ecological groups on the diversity and

composition of understory plant and soil invertebrate communities in North American forest ecosystems.

We obtained data from field studies across North American forest ecosystems that reported abundance of exotic earthworms in combination with either abundance and diversity of understory plant communities (diversity: 288 observations, 12 studies; abundance: 788 observations, 13 studies) or diversity of soil invertebrate communities (15 observations, 6 studies). For each study, earthworm abundances were aggregated by ecological group (EEG), as was relative abundance for plant growth forms and native status. Correlations between abundances of earthworm and plant communities were determined and transformed to Fisher's Z-scores. For soil invertebrate communities, log response ratios were calculated as the response to exotic earthworm presence.

We found that the identity of the EEG and the number of EEGs present strongly determined diversity and composition of plant and soil invertebrate communities. The abundance of endogeic and, to a lesser extent, anecic earthworms strongly reduced species diversity and richness of understory plant communities. Similar patterns were observed for soil invertebrate communities. The abundance of grasses increased uniformly in the presence of all EEGs. While the abundance of native species remained stable in invaded areas that of introduced grass and woody species increased with the number of EEGs present. Our results suggest that exotic endogeic earthworms strongly decrease the biodiversity of above- and belowground communities and pave the way for other invasive species in North American forests.

O7 - A global synthesis of patterns of naturalized alien plants based on the Global Naturalized Alien Flora (GloNAF) data base

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Humans have intentionally and unintentionally introduced many species from their native regions into regions where they did not previously occur. Some of them have become naturalized, and some of those have become invasive. However, we still know little about patterns and drivers of distributions of naturalized and invasive alien plant species at a global scale. Together with an international consortium, we have compiled a global database for naturalized alien plants (GloNAF), which includes 12,615 species and 827 non-overlapping regions. We will use this database

to answer global questions such as: (1) Which plant species are most widely naturalized and invasive globally? (2) Which plant families have the largest and the smallest numbers and proportions of species that are naturalized and invasive, and how does this taxonomic bias vary among regions? (3) Which continent is overall the major donor of naturalized and invasive alien species, and how does the identity of the major donor continent vary among receptor regions? In short, we will present the first global synthesis of patterns of naturalized and invasive alien plant species distributions.

O8 - The “effective mesh size index” as a predictor for regional patterns of vascular plant species richness

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Landscape fragmentation and habitat loss have been identified as major threats to biodiversity worldwide. In this context, several landscape metrics have been developed that quantify fragmentation. One of these indices, the effective mesh size index (m_{eff}), has frequently been used to evaluate the degree of landscape fragmentation. However, until now, its relevance for biodiversity has been rarely evaluated. In our analysis, we thus aimed at analysing the explanatory power of m_{eff} on richness patterns of different groups of vascular plant species (all species, and species groups by naturalisation and threat status; information taken from the data base of the vascular plant assessment program of Lower Saxony) in Lower Saxony, Germany, by using a regular grid of 1386 landscape units (each c. 30 km² in size). Based on a digital landscape model, we assessed the degree of fragmentation of each study unit by calculating m_{eff} . We tested five types of m_{eff} based on various fragmentation geometries (FGs; i.e. landscape elements that are assumed to fragment the landscape). Out of these, two types were identified as relevant for species richness. These were based on fragmentation geometries that included urban-industrial and traffic areas as well as water bodies. We found that m_{eff} had a rather large effect on richness of neophytes and, to a smaller extent, on that of archaeophytes whereas richness of native species was only slightly affected and that of threatened species not affected.

We conclude that m_{eff} is a meaningful tool to explain richness patterns of vascular plant diversity, if relevant fragmentation geometries are chosen. Our approach may therefore help future studies to determine correct fragmentation geometries to use with m_{eff} and may facilitate the unravelling of fragmentation impacts on the landscape-scale.

O9 - Knowledge Integration and Synthesis Using Semantic Technologies

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In our contribution, we will present our ideas on how to achieve information integration and synthesis within the recently launched Collaborative Research Centre AquaDiva by employing a novel combination of semantic knowledge management, information extraction and personalization techniques. AquaDiva is targeted towards the question of how environmental conditions and surface properties determine the functional biodiversity of the subsurface as part of the Earth's Critical Zone. Answering this question involves the linking and synthesis of a large volume of heterogeneous data. We will achieve data integration through the use of a common machine-readable knowledge base in terms of interlinked domain ontologies and semantic annotations. Thereby, we will not only focus on information residing in structured data, e.g. Excel tables, but also on knowledge extracted from documents such as scientific publications, which is typically not directly comprehensible by information systems. Particular emphasis will be put on adequately and richly describing dynamic aspects of biological phenomena, which are often encoded in biological models. This is important, since this kind of knowledge has the potential to elucidate the basic mechanisms that drive biodiversity. However, we will not only integrate information, but also richly interlink these to make them accessible for ontological reasoning, a powerful, but mostly unused instrument for knowledge synthesis and discovery. In fact, we will go beyond providing just access to explicit information by offering search functionality, but will rather establish a platform that allows for semantic computing over integrated data to derive new hypotheses and yet undiscovered facts and evidence. Finally, we intend to provide personalized features that will enable researchers to efficiently identify relevant information within the large knowledge base and will allow them to do this at a level which is suitable for non-computer scientists.

O10 - Land use change and biodiversity: modeling the impact of roads on carnivores

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Land use change is a major driver of biodiversity loss, with roads impacting populations through direct mortality and/or habitat fragmentation and degradation. Carnivores' low population growth rates and great mobility can render them susceptible to roads. However, little is known about the effect of roads on population viability. We determined which carnivore species are more affected by roads at the global level, and the spatial match between the number of species affected and road density. We used a process-based, reaction-diffusion model describing population dynamics to predict the impact of a road network on a population including: dispersal distance, growth rate in favorable natural habitat patches, and growth rate in roads. To rank the species most affected by roads we used maximum road density, and the minimum size of the patches between roads, above or below which populations cannot persist. For each species, we computed: 1) the maximum road density and the minimum patch size, using species-specific life histories and road mortality data; 2) the road density, and the number and size of the patches between roads that are observed within each species range; 3) the ratio of maximum to observed road density and the number and area of patches that are bigger than the minimum patch size. We selected the species within the 5% percentile for these quantities as the most affected species. We found that family Ursidae has the highest percentage of species within the 5% most affected, followed by family Felidae and Canidae. We also found that 54% of the most affected species are not threatened by roads according to the IUCN, including 10 species that currently have a "Least Concern" status. The highest numbers of species affected by roads are found in Europe, North and Central America, South of Asia and China, and central-east Africa. However, while in Europe this high number of species is matched by high road density, this is not necessarily the case in the other regions. Our approach can be extended to any species for which the necessary life history data can be obtained, and assist in developing conservation and mitigation measures. Furthermore, it can be applied at different spatial or temporal scales, such as projecting the impact of future road network development.

O11 - Can artificial waterways provide a refuge for floodplain biodiversity?

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Rivers and floodplains are hot spots of biodiversity in Middle Europe. Intensive anthropogenic influence has led to a loss of floodplain area and poses a threat to their ecological functionality. This is especially the case for waterways, which have been subject to river engineering due to their economic importance and thus have lost a significant amount of their original floodplains and biodiversity.

Canals as artificial waterways have been proven to serve as a refuge for several aquatic species groups where their original habitat is impaired or lost. However, the potential to preserve terrestrial macrophytes and biodiversity along their banks has rarely been studied. Thus, the question arises whether canals can provide, at least partly, suitable habitat space to sustain species diversity and functionality of floodplains.

In the present case study, we compared the floristic, functional and structural diversity of the floodplain and the respective adjacent areas of the river Ems and the Dortmund-Ems Canal in North Western Germany. We studied terrestrial plant species composition along the banks of the water bodies, we detected differences in biodiversity on several levels, and we determined influencing factors in biodiversity distribution. Our results could serve as an orientation for an adapted biodiversity management in the respective areas.

O12 - Designing Ecosystem Assessments as Policy-Relevant Biodiversity Syntheses - Experiences from Scoping a German NEA

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Assessments of ecosystems and their services have the capacity to support policy and decision-making by providing a synthesis of best available knowledge as relevant for the decision options at stake. Designing and implementing such assessments however requires a transdisciplinary approach that balances the interests and expectations of potential users and stakeholders with the capacities of scientists. The potential users need to be systematically involved in framing, objective setting and at several implementation stages. Vice-versa, scientists need

to understand the interests of policy makers and to adapt their concepts and methods to provide the kind of information asked for. Finally, procedural innovations such as extended peer review and new forms of research dissemination are required.

This contribution explores these challenges, and potential pathways for overcoming them, by drawing on the experiences from a Scoping Study for a National Ecosystem Assessment in Germany. We introduce the German institutional and scientific context, identify potential research questions for a national ecosystem assessment, and suggest different options for implementation. We finally discuss lessons learned with relevance for other assessments, for example the need for continuous expectation management among participating policy makers and scientists.

O13 - Biodiversity in input-output analysis

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In 2010, the European Union established its growth strategy for the ten years ahead, the EU 2020 Strategy. The strategy states that Europe should seek a smart, sustainable and inclusive growth. The Resource-Efficient Europe is one of the flagship initiatives of the EU 2020 Strategy, framed under the principle of sustainable growth. It seeks to support the transition to a resource-efficient and low carbon economy by boosting economic performance while reducing resource use, ensuring the security of supply of essential resources as well as fighting climate change and limiting the environmental impacts of resource use. The Roadmap for a resource-efficient Europe identified the need for robust and easily understandable indicators to provide signals and measure progress in improving resource efficiency. One area of resource use that still lacks robust indicators is biodiversity and ecosystem services. Input-output analysis has been widely used to link carbon emissions and consumption patterns, thus providing information on the carbon efficiency of different economies not only at the European level but also at the global level. In this work, we review the applications of input-output analysis to study how consumption depends on and aspects ecosystems and biodiversity. We end by provide suggestions of future research in the development of biodiversity and ecosystem services indicators that can be used to measure progress towards resource efficient economies, within an input-output framework.

O14 - Social-Ecological Systems - A Framework for Transdisciplinary Biodiversity Research

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Transdisciplinary biodiversity research is *critical*, as biodiversity research addresses more and more the underlying societal causes of biodiversity dynamics; it is *important*, to improve communication and collaboration between researchers and policy demand; and it finally *asks* for scientific academic training to provide means and opportunities for new professionals.

Referring to our conceptual model of transdisciplinarity, we seek to discuss this model in the context of global biodiversity dynamics and its societal relevance. In particular the three consecutive steps of an ideal transdisciplinary research process such as 1) problem transformation; 2) interdisciplinary integration; and 3) transdisciplinary integration will be explained.

The subject of transdisciplinary biodiversity research lies at the interface of society and nature. Social-ecological systems (SES) conceptually formalise this interface and therefore are one possible form of realising transdisciplinary research by creating a link to research practice. During the last decades, the concept of SES has become increasingly important to the international discourse of sustainability science describing, analysing and modelling human-nature interactions. However, recent studies link SES with the concept of ecosystem services. This progressive attempt allows a strengthening of the concept of SES regarding the questions of how to systematically conceptualise the feedback of benefits to society.

Referring to this discussion, we present our concept of SES in its three different functions of an idealised transdisciplinary research process: 1) a heuristic function to structure and describe a common research object; 2) an analytical function to derive research questions guiding the solution-oriented research process; and 3) an integration function to evaluate the results against their contribution to societal and scientific progress.

O15 - A collaborative project to assess the impacts of climate change on population trends

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Understanding which types of species are showing the greatest response to climate change will help determine the consequences for communities and ecosystems. A recognized fingerprint of climate change in local communities is a positive relationship between species temperature niche and its population trend. We have brought together long-term local population data sets on different taxonomic group in regions of Central Europe. For each data set, we have tested the ability of species attributes to explain interspecific variation in long-term population trends. By comparing the effect of species temperature niche across data sets, we can test the generality of the prediction that warm-adapted species have been favored by climate change over cold-adapted species. We present the results of our analyses comparing terrestrial, freshwater and marine systems.

O16 - Ecological networks in the light of climate change: Adaptation strategies in the Dutch-German border region

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Ecological networks are proclaimed to be an adaptation strategy to help species adjust to climate change, facilitating range expansions. This paper presents a method to (a) identify species which are potentially vulnerable to the predicted climate change and rely on ecological networks in the Dutch-German border region, and (b) assess whether the existing ecological network in the border region is climate proof.

Using the distribution data and climate envelope models for 846 species in Europe (mammals, birds, reptiles, amphibians, and butterflies), we identified 303 species with climate-induced range shifts in the Dutch-German border region. A range expansion is predicted for 99 species and the ranges of 204 species are predicted to contract. The spatial cohesion of the ecological network was analysed with the habitat network assessment tool LARCH for four selected species that vary in habitat requirements and colonization ability. The assessment showed that optimizing transboundary networks seems a suitable adaptation strategy for *Lutra lutra* and for the forest species *Brenthis daphne* and *Dendrocopos medius*. For the immobile wetland butterfly *Maculinea teleius*, the present habitat network is too weak and translocation into future suitable climate space seems to be a more appropriate adaptation measure.

Our results show that due to climate change landscape planning should not only focus on areas where target species occur today. The presented method can identify strongholds and bottlenecks in transboundary ecological networks and incorporate the demands of climate adaptation into spatial planning which forms the basis for taking measures at a more detailed level. We recommend considering the identified species with cross-border range shifts in national lists of target species and national ecological network concepts in Germany and in the Netherlands.

O17 - Biodiversity effects on soil microbial respiration in a global network of eleven tree diversity experiments

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The relationship between biodiversity and ecosystem functioning (BEF) is a hot topic in current ecological research. Many ecosystem functions and services are provided by the belowground system, e.g., decomposition and nutrient mineralization, although BEF research has only recently started to acknowledge the significance of soil organisms. Microorganisms are the main drivers of such processes and understanding their response to changes in plant diversity will help to mechanistically understand the links between plant diversity and ecosystem functioning. A critical step is to come from single observations to deriving general patterns, e.g., by using the same high-throughput analyses in many experiments in different abiotic and biotic contexts. We use the substrate-induced respiration (SIR) method to 1) measure different soil microbial properties (respiration, microbial biomass, carbon use efficiency) in different tree diversity experiments, 2) identify tree species, which may have a strong influence on soil microbial properties, and 3) identify and evaluate other tree diversity- and identity-mediated factors being important for soil microorganisms. With this global approach we aim to extract general patterns in the relationship between tree diversity and soil microbial respiration.

P1 - Impacts of biodiversity change on the coupled water-vegetation dynamic in drylands

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Semi-arid ecosystems are characterized by a strong coupling of water and vegetation dynamics. Altered water availability as a result of climate change will likely trigger the occurrence of new species and loss of native species, since different plant functional types (PFTs) do not respond equally to a change in the water content. This shift in vegetation composition and cover will in turn impact water dynamics. On the other hand, especially under varying climatic conditions, trait variability within PFTs and the presence of a variety of response traits may stabilize ecosystem dynamics.

Current ecohydrological models of dryland dynamics aggregate plants into very few plant functional types, and the trait parameters of these PFTs only describe mean values for homogeneous PFTs instead of trait variability. To approach this shortcoming, we extended the ecohydrological drylands model EcoHyD, which up to now simulated the fate of three rather general PFTs, namely shrubs, perennial and annual grasses, by sub-dividing the three broad PFTs into several sub-PFTs. This sub-classification was based on different traits relating to morphological aspects, such as rooting depth, leaf area index, seed establishment and traits relating to drought stress and grazing response.

We apply the model to a semi-arid savanna in southern Africa and assess the feedbacks of trait diversity on water allocation and vegetation composition under different climate and grazing scenarios. We will be able to assess the response of various PFTs with different traits to climatic conditions and the resulting feedbacks on soil moisture. In addition, the results allow for drawing conclusions on how water dynamics impact biodiversity and how biodiversity in turn affects the stability of semi-arid ecosystems under climate change.

P2 - Looking at an epidemiological study through the eyes of an microbial ecologist

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The LISApplus project is a large longitudinal birth cohort study, accompanying more than 1700 children from birth to youth and adulthood. One of its main objectives is to reveal environmental conditions influencing the prevalence of atopic diseases, e.g. asthma and allergic rhinitis. Its resources are questionnaires and medical samples, among others.

An additional emphasis is on the microbial exposome, i.e. revealing the fungal and bacterial exposure via analyzing dust of children's homes and identifying patterns relating to an induced or suppressed development of allergic diseases throughout childhood. Commonly, biochemical markers like lipopolysaccharide or ergosterol are used to that goal.

Such datasets are now occasionally complemented by methods of microbial ecology as sequencing or DNA-fingerprinting. Because of the sample sizes used in epidemiological studies and their comprehensive meta-data, the resulting molecular data may not only be mined through for health related patterns, instead it is also an opportunity for general insight into the parameters defining the microbiology of indoor dust - an environment in touch with all of us.

Consequently, we show the ecological picture unfolding through the analysis of more than 200 fungal and bacterial DNA-fingerprints based on t-RFLP which were sampled as part of the LISApplus project.

END OF SESSION 4

Session 5 - Biodiversity & conservation tropics/subtropics

CHAIR: JASMIN MANTILLA-CONTRERAS

O1 - How changes in land cover affect reptile diversity in south-western Madagascar

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Many anthropogenic alterations of natural ecosystems have been shown to affect species diversity. Generally, species survival depends on the availability of habitat that can be occupied. The 'habitat heterogeneity hypothesis' proposes that the more available habitats there are in a given area the more species can co-exist. Alterations of landscapes that increase structural heterogeneity should consequently lead to increased species richness whereas alterations that decrease structural heterogeneity should decrease species richness. Several processes have been identified that diminish species diversity, from drastic interventions like deforestation to more subtle ones like extensive grazing and dead wood collection. Our study aimed to identify factors of human land use that lead to changes in species diversity. We hypothesized that species richness positively correlates with habitat heterogeneity.

We investigated the generality of the 'habitat heterogeneity hypothesis' by studying reptile diversity in south-western Madagascar. We compared species richness on 120 transects between seven land cover classes in and around the Tsimanampetsotsa National Park. The land cover classification was based on structural indices derived from remote sensing data. As expected species richness was positively correlated with structural heterogeneity. Open forest habitats with a canopy cover of 40% were the structurally most diverse habitats and harbored highest species richness, whereas agricultural land and grasslands were structurally most depauperate and harbored lowest species richness. So, structural complexity of the landscape is important for the maintenance of species diversity. In many systems there is a positive correlation between species richness and functional richness. A diminished diversity hence may affect the stability of ecosystems as well as ecosystem functioning. Land use management should consider preserving structural heterogeneity to stabilize species diversity.

O2 - Thermal ecology of Malagasy lizards along a steep environmental gradient

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Temperature is a crucial aspect in reptiles' biology. It affects almost all stages in their life-histories and it is a restricting factor for their geographical distributions.

Depending on the thermal niche and the mode of thermoregulation (thigmotherm or heliotherm), lizards are able to inhabit a range of habitats. Particularly heliotherm lizards attempt to reach and maintain a target temperature (T_{pref}) for optimal body functions. However, this is only possible within the operative environmental temperature of the habitat. In order to find out whether the species show physiological adaptation or compensate temperature differences through behavioural adjustment, we investigated the thermal ecology of three Malagasy lizards (*Oplurus quadrimaculatus*, *O. saxicola* and *Zonosaurus laticaudatus*) using infrared thermometer, temperature loggers, thermocouples and focal observations. The study took place at three sites in the natural habitat of the three species with significantly different thermal conditions (spiny forest: hot, gallery forest: moderate and rain forest: cool). Temperature profiles of the species show high behavioural flexibility, expressed as differences in activity time. Physiological adaptations, expressed as differences in T_{pref} , is present but less distinct. We also found that the lizards are better able to cope with, and thus less limited by, high temperatures rather than low temperatures which explains their distribution restricted to the semi-arid southern part of the island.

O3 - Current problems and future challenges for the Lake Alaotra wetland complex, Madagascar

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The Lake Alaotra wetland complex represents the biggest wetland system in Madagascar and is home for several specialized plant and animal species. In addition, the local population in the area depends entirely on the lake and its freshwater marshes. Due to several factors, the area is highly degraded. The hills surrounding the lake are deforested and its erosion causes lake siltation. Invasive plant and animal species have increased during the last decades and threaten local species and biodiversity. However, the main problem of the area is poverty and the overuse of the natural resources. In this study we investigated water quality parameters and vegetation at three sites around the lake with a different level of degradation.

Our results show that the lake is already in a bad condition. During the dry season, water levels are very low and followed by high water temperatures. In the rain season large amounts of nutrients enter the lake and cause hypoxic conditions

affecting aquatic species and the whole food web. The natural vegetation is mainly threatened by human disturbances and invasive species.

The current and future challenges of Lake Alaotra are: (1) the continuous shrinking of the lake due to a lesser water recharge in the lake and sedimentation, (2) changes in plant species composition and density due to invasive species and the destruction of the marsh belt, (3) increasing nutrient discharge into the lake due to municipal wastewater and fertilizers, (4) changes in aquatic species composition and trophic web due to hypoxic conditions and (5) less fish catches and displacement of endemic and native species due to fish invasions and overfishing.

If there are no major changes in the use and management of the natural resources, not only biodiversity but also the livelihood of the local people are endangered.

O4 - The Role of local communities in species conservation and ecology monitoring

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The Aspinall Foundation – Madagascar programme is a non-governmental organisation which works with local partners to try to protect endangered species and their habitats from extinction. Here in Madagascar, our focal species are lemurs and we have begun with *Prolemur simus*, which was classified by IUCN on 2008 and 2012 as an endangered species and the 5th threaten primate in the world. Now we are extended our action into other species like *Crowned sifaka*, *Varecia variegata sp*, *Propithecus diadema*, *Indri indri* or *Daubentonia madascariens*.

Since our installation on 2009, we identified and developed management mechanisms in collaboration with local communities to which management of the forest is transferred, for the persistence of the species on which we are working and their potential role as sources for release stock for potential future translocation, reinforcement or reintroduction strategies. Training, awareness and education were run during five years to help local community to better understand their role and responsibility as users and protector of forest. In our site, where people use to hunt and trap lemurs, practice slash and burn culture, illegal logging, survival and abundance of lemur sighted is considered as an indicator of forest good management. We actually increase known group and individuals of *Prolemur* and never had lost new babies during our 5 years of collaborative works and ecology monitoring with local communities.

O5 - A matter of straw-Invertebrate contribution to decomposition depends on crop residue management practices in tropical rice fields

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The reduction of fertilizer application by promoting natural processes in nutrient cycles is a key factor for a sustainable management of agricultural systems. As rice is one of the most important food resources in the world, sustainable management of rice paddies is increasingly in demand. Up till now, little is known about the influence of invertebrates on decomposition processes in these ecosystems. Therefore we conducted an experiment in the lowlands of the Philippines which aimed to assess the influence of invertebrates to the decomposition of rice straw in paddies and the mediating effects of crop residue management practices. We set pairs of rice straw filled litterbags of two different mesh sizes that prevent (20 × 20 mm) or allow (5 × 5 mm) access of invertebrates in irrigated rice fields. The experimental setup was arranged in five blocks and five different crop residue management practices, commonly used by farmers in this region, were randomly distributed within each of the blocks. Litterbags were retrieved 25, 50 and 75 days after their setting (the setting took place one day after transplanting of the rice seedlings). Further, soil core samples were taken to examine the mesofauna within the soil and water dip net samples as well as suction samples were used to identify the water fauna and the fauna directly related to the rice plants. This experiment allows us to show short term effects of different crop residue management practices on the decomposition efficiency of invertebrates as well as the general effects on diversity and abundance of representatives of the food web in a rice field.

O6 - Influence of habitat structure on the diversity and pest control efficiency of egg parasitoids in Philippine lowland rice

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Hoppers in rice increasingly develop resistance to insecticides and adapt to different resistant varieties, respectively. In rice ecosystems, mirid bugs, spiders and egg parasitoids are known to be the main antagonists but little is known especially about the latter. In other agroecosystems it has been shown that a high rate of egg parasitism can effectively control pests, making it important to investigate their role within the rice ecosystem.

This research addresses the question, whether habitat structure can affect the diversity and efficiency of the egg parasitoids of two major rice pests, the brown planthopper, *Nilaparvata lugens* (BPH) and the green leafhopper, *Nephotettix spp.* (GLH).

To investigate this, rice plants infested with eggs of one or both species were placed within landscape gradients in rice dominated landscapes for three days allowing parasitization by the local parasitoid populations. The landscape gradients included passively managed polystructures, rice fields adjacent to these polystructures and rice monocultures.

Levels of egg parasitism varied between 0 and 58% for BPH and 0 and 73% for GLH. Egg predation could also reach high levels, especially in the polystructures. The BPH eggs were mainly parasitized by *Oligosita sp.* and *Anagrus sp.*, while GLH eggs were mainly parasitized by *Gonatocerus spp.* and *Paracentrobia sp.* We found no differences between the paired rice fields; however, parasitization and parasitoid species richness was significantly higher in the rice fields than in the polystructures. Our results show that egg parasitization plays an important role in controlling these two pests and that the performance of hopper parasitoids, contrary to our hypothesis, does not depend on the availability of retreat areas or external nectar sources.

O7 - Regional land use intensity and local habitat complexity affect pollinator abundance in rice production landscapes

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Agricultural intensification is one of the main drivers for pollinator declines due to fragmentation of natural habitats, loss of crop diversity and use of pesticides. Pollination can benefit the yield of approximately 85% of world crops, especially in vegetables and fruits with high nutritional value for people's diets. We investigated whether structural diversity and land use intensity in rice ecosystems had an

influence on pollinators comparing two provinces (lowland and upland) on the Philippines. Furthermore, we tested the hypothesis that isolation from agroforests and decreasing habitat complexity negatively affect bee abundance and species richness especially in the lowland province. Accordingly, we hypothesized that agroforests represent important bee habitats since they provide important nesting and foraging sites.

We selected landscapes in poorly structured lowland (Laguna) and richly structured upland (Ifugao) with large and small field sizes respectively. Within these landscapes we analyzed bee abundance and species richness in dependence of structural complexity of habitats and isolation. Bees were sampled with transect walks in rice paddies with structurally simple and complex surroundings and in agroforests adjacent to the rice fields as source habitats.

Significantly fewer bees were recorded in the structurally simple habitats compared to the complex ones in the lowland region, but species richness was not affected by isolation from agroforests. Greatest bee densities and species numbers were observed in the agroforests. Further, habitat structure influenced bee abundance and species richness in interaction with flower coverage positively in the rice paddies but no effect of flower coverage on bee abundance was found in agroforests and even a negative effect for species richness.

Agroforests represent the most important bee habitats in rice production landscapes and thus they should be maintained and further developed to counteract detrimental effect of land use intensification on pollinators. Further, ecological engineering measures like sowing of flower strips and increasing landscape heterogeneity (catch crops, home gardens, organic farming) and flower cover within the rice fields would further benefit pollinators.

O8 - Ants in a heterogeneous environment: Do trophic groups matter?

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Understanding how species communities in heterogeneous habitats respond to environmental gradients is critical to predict community responses in a rapidly changing world. We used ground-dwelling ants collected with pitfall traps in 27 plots in the highly diverse subtropics of South-East China to investigate if and how ant diversity relates to a comprehensive set of biotic (e.g. tree diversity, forest stand age) and abiotic environmental variables (e.g. soil properties, elevation). In total, we collected 13,441 ant individuals belonging to 71 species. As expected, ant species richness decreased with elevation, but was, unexpectedly, not related to tree diversity or to stand age. An NMDS ordination showed that community composition among study plots differed considerably along gradients of elevation and stand age. However, the results changed after the main trophic groups of ants,

exclusive predators and omnivores, were analyzed separately. While richness and evenness of the 45 omnivore species were only influenced by soil pH and variables dependent on stand age, respectively, richness and evenness of the 26 predators were positively related to tree diversity.

In conclusion, our results demonstrate (1) that even younger forest stands may, independently of their tree diversity, support a diversity of ants that is similar to old-growth forests and thus worth protecting, especially in areas like South-East China where deforestation was severe and no primary forest is left. However, (2) our results also show that only predator ants benefit from forest stands with high tree diversity, suggesting that the vulnerable ecosystem processes dependent on predation may be less pronounced in less diverse forests. Finally, our results highlight the importance to analyze trophic and functional groups inside a taxon separately, as we were only able to disentangle the effect of tree diversity on predators after splitting the total ant community into trophic groups.

O9 - Combined effects of herbivory and drought on the distribution of tree species along a tropical rainfall gradient

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Tree species distributions associated with rainfall are among the most prominent patterns in diverse tropical forests. Beside direct effects of water availability, other factors that co-vary with rainfall may be responsible for this pattern. Herbivory (damage due to herbivores and pathogens) has long been hypothesized to shape tree species distribution and diversity.

We tested the hypothesis that higher herbivory in wet forests prevents less defended dry origin species from growing in wet forests (pest pressure hypothesis). Drought on the other hand prevents less drought tolerant wet origin species from growing in dry forests.

In a reciprocal transplant experiment at a wet and a dry forest site in Panama, seeds of 26 species with contrasting origin were planted. Half of the seeds and the resulting seedlings received a combined treatment of an insecticide and a fungicide to exclude herbivory. Germination and survival of the seedlings were recorded during one year, corresponding to one wet and one dry season.

The herbivore exclusion significantly increased the performance during germination and early seedling stage. However, we did not find a higher effect in wet forests for dry origin species. Instead, the effect was higher at the dry site for dry origin species. As expected, the survival of wet origin species at the dry site was reduced during the dry season, indicating that drought limits the establishment of wet origin species in dry forests.

In conclusion, although herbivory is an important factor for establishment success in tropical forests, our results did not support the pest pressure hypothesis for the seed and early seedling stage. Other life stages, species traits or environmental factors like nutrient availability may be more important in limiting the occurrence of dry origin species in wet forests. Drought on the other hand limits distribution of wet origin species.

O10 - Community experiments reveal the impact of habitat restoration on pollination networks

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Islands harbour a large proportion of the world's threatened biodiversity. To preserve and restore this biodiversity it is crucial to maintain biotic interactions vital for ecosystem functioning. Pollination plays a pivotal role in the long-term persistence of native plant communities, and pollination networks can be used to assess the current status and the effectiveness of restoring native island communities. Here we present experimental evidence on the effects of habitat restoration on plant-pollinator communities. We use network analysis to shed light on the impact of habitat restoration on the structure and dynamics of island pollination networks and draw conclusions on the robustness of this ecosystem function to anthropogenic disturbance. Finally, we discuss opportunities and challenges inherent to the application of complex ecological networks in conservation management.

P1 - Tick burdens of the Madagascar spider tortoise *Pyxis arachnoides*

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The dry forest of south west Madagascar is a severely threatened habitat with the two endemic tortoise species *Pyxis arachnoides* and *Astrochelys radiata* facing threats from several human activities. The ixodid tick *Amblyomma chabaudi* is supposed to be a host-specific tick of *Pyxis arachnoides*, but there is a lack of knowledge of its potential role as a vector. The aims of the study were (1) to examine the occurrence of ticks in relation to the status of habitat degradation, and (2) the investigation of tick-borne pathogens.

The sampling of tortoises and collection of ticks was carried out in two sites with different level of human disturbance in southwestern Madagascar. The Tsimanampatsotsa National Park was defined as an area with low disturbance. The adjacent regions outside the park with obvious evidence of livestock grazing and deforestation were classified as disturbed.

Under the assumption that habitat degradation has negative effects on an animal's health, body condition of tortoises was measured as an indicator of habitat quality. We hypothesized that tortoises in good condition would have fewer ticks.

120 tortoises were found: 78 *Pyxis arachnoides* and 42 *Astrochelys radiata*. Only one tick was feeding on *A. radiata* confirming that *Amblyomma chabaudi* is, at least the adult stage, specific to *Pyxis arachnoides*. Tick infestation rates of *Pyxis arachnoides* differed significantly between the two study sites. 36 *Pyxis arachnoides* were found inside the national park, 8 of which were infested by 1 to 4 ticks resulting in a prevalence of 0.22. The prevalence outside of the park was 0.76 with 32 of 42 tortoises infested by 1 to 7 ticks. The 8 infested tortoises inside the park altogether carried 13 ticks equating to a mean intensity of 1.6 whereas the 32 infested tortoises outside of the park carried 60 ticks (mean intensity: 1.9). The mean abundance of ticks per tortoise was 0.4 inside the park and 1.4 outside of the park, respectively.

Body condition of tortoises was estimated by the residuals of a regression of log-mass against log-length data as well as by calculating tortoise "density" mass/(length*width*height). No difference between body condition inside and outside of the park was discovered. Nor was there a correlation between tortoise condition and tick infestation.

Detection of pathogens was conducted via PCR on DNA isolated from ticks using genus-specific primers. The *Amblyomma chabaudi* ticks revealed an infection rate of 100% with *Rickettsia africae*. Relapsing fever *Borrelia* and *Babesia ssp.* were not found.

P2 - Diversity of amphibians and reptiles at Lake Alaotra, Madagascar

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Madagascar is one of the most important biodiversity hotspots and especially known for its high rate of endemism. This is especially the case for amphibians and reptiles. Research on the herpetofauna of Madagascar has so far focused mainly on forest ecosystems and not on other ecosystems. In addition, focus has been given mainly to protected areas such as National Parks and not to unprotected areas. For the biggest wetland in Madagascar- the Alaotra wetland complex, so far no

inventory exists and it is unclear how diversity of amphibians and reptiles is influenced by nature degradation. In this study we investigated the occurrence of amphibians and reptiles in three regions at Lake Alaotra (Vohimara, Andreba and Anororo) which represent different levels of degradation (from low to high degradation). In addition to field work, a questionnaire study was undertaken with different stakeholders to reveal the knowledge and attitude towards amphibians and reptiles by the local population in the three regions.

The results of our study show a very low species diversity of the herpetofauna (only 18 species were found in total) compared to a protected areas in Madagascar with primary vegetation and show great differences between the three regions and the level of degradation. In our study, we mainly found widespread species and no species which were endemic to the region. Diversity loss was clearly linked to degradation, as most species were found in Vohimara- the region with low degradation and only a few in Anororo- the region with high degradation. Loss of (natural) vegetation seems to be one main driver for species loss. Nevertheless, some species also benefited by the habitat changes and by human buildings. The questionnaire supported the results of the field work and showed that many people fear reptiles and amphibians due to various misconceptions or religious reasons. The survey also revealed that in former time crocodiles and turtles were part of the herpetofauna of the lake but are now extinct. The high degradation level of the area and the complete loss of forest explains the low diversity of amphibians and reptiles and assumes that several species might have been already extinct in the area. To preserve the present herpetofauna, conservation strategies should focus on sustainable land management, restricted areas without use and environmental education to change the opinion of locals against amphibians and reptiles.

P3 - Biodiversity value of agroforestry systems threatened to oil palm conversion in Southwest Cameroon

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Recent activities in West Africa indicate that oil palm production will play a major role for conservation and development activities in the African tropical forest zone. Rural agroforestry and natural forest ecosystems are now facing a substantial threat caused by land use change. The largest continuous forest block of that region, the Gulf of Guinea Forests, is acknowledged as biodiversity hotspot and centre of endemism. The protected areas of that region harbour an exceptionally diverse species pool. However, there is a lack of knowledge on the biodiversity and conservation value of the forests surrounding them: a forest matrix of primary and secondary forests as well as traditional agroforestry systems primarily based on

smallholder farms, which is now in the focus of oil palm development. Between April and June 2013 we systematically surveyed an area of 70,000 ha between Korup and Bakossi National Park, Banyang Mbo Wildlife Sanctuary and Rumpi Hills Forest Reserve for wildlife and tree species using transect walks and vegetation plots, respectively. The study area was proposed for an oil palm project by an American agribusiness company. While the environmental impact assessment assigned by the investors described the area as degraded, our survey revealed populations of endangered species, such as Elliot's Chimpanzee, Mainland Drill, Preuss' Red Colobus and Central African Elephant. In addition, we encountered exceptionally high tree species diversity with more than 60 tree species of conservation concern. We concluded that large parts of the potential concession area need to be considered as high conservation value and should, therefore, be protected from conversion to oil palm plantation. This case study illustrates the urgent need for unbiased and systematic biodiversity assessments in the context of current agro-industrial developments as well as the significance of scientific support for conservation activities.

P4 - Effects of vegetation and climate on the abundance of epigeic arthropods along the slopes of Mt. Kilimanjaro, Tanzania

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The majority of humanity depends on processes provided by mountain ecosystems. These processes depend on abundance and diversity of organisms, which underlines the need for understanding the patterns of assemblages along elevation gradients. Mt. Kilimanjaro is the highest solitary mountain in the world. The slopes of the mountain span a gradient from savannahs at ca. 700 m a.s.l. up to the ice covered summit at 5895 m a.s.l., with numerous distinct vegetation types. Furthermore, the mountain has a long tradition of land-use (Chagga homegardens). This diversity of vegetation and land-use types provides an opportunity to study links between elevation, land-use, biodiversity and ecosystem services. Here we report on the elevational patterns in the abundance of epigeic animals. This abundance should increase with rainfall and decrease with elevation leading to a hump shaped pattern at mid elevations.

We sampled epigeic arthropod communities with pitfall traps in 12 vegetation types with five replicates of each type. These types cover an elevation as well as a land-use gradient. We repeated the sampling five times within two years. The most abundant lineages were Collembola (33% of 173804 sampled individuals), Acari (22%), Formicidae (10%), Coleoptera (5%) and Araneae (2%). Although total abundance showed the expected hump-shaped pattern with a peak at ca. 2000 m a.s.l., individual lineages showed quite different responses to elevation. Only

Collembola, Formicidae and Coleoptera showed a hump-shaped pattern, however, with some variation in the location of the peak between taxa. In contrast Acari showed a decrease in abundance with elevation whereas spiders showed no clear pattern. We found a strong decline in the relative abundance of carnivores from more than 35% on the savannah sites towards 5-10% at high elevations suggesting a decrease in the length of food chains with elevation. Unexpectedly, even intense land-use had not always a negative effect on the abundance of epigeic animals. The traditional Chagga homegardens showed a lower abundance of epigeic animals than coffee plantations.

P5 - Pollination services depend on local and landscape heterogeneity in rice dominated regions

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Hymenopterans fulfill different kinds of ecosystem functions like pollination and parasitism that are not only essential for the stability of ecosystems and also benefit humans which turns them into ecosystem services.

Especially the ecosystem service of pollination, mostly accomplished by bees, is highly important for entomophilous crop plants including many vegetables and fruits. Increasing intensification of agricultural practices in rice-dominated landscapes might threaten pollination services that are essential for yield and quality of fruits and vegetables, which are vitamin and nutrient rich supplements of the diets of many rice-farming families

We hypothesize that

1. The abundance and richness of bee species is higher in gardens that are located in complex than simple landscapes, characterized by the amount of woody landscape elements.
2. Both bee species richness and abundance depend also on the local availability of floral resources in and around the gardens.

We selected ten study landscapes in the central mountain range of Luzon, Philippines, located in agricultural rice landscapes representing different levels of landscape heterogeneity. In each landscape, two home gardens, which were managed by local rice farmers, were selected. One garden was mainly surrounded

by rice fields and one garden was adjacent to structurally complex agro-forests. The different habitat types around each garden were mapped within a radius of 100m. Further, land cover types were quantified within a radius of 300m around the center point of both gardens.

Bees were caught within a 90 m x 4 m transect in the close vicinity to the gardens for four times from February to April for 4 x 15 min. Additionally all flowering plant species and their flower cover were recorded.

Overall 354 bee specimens were recorded on 24 different plant species. The distribution of the bees suggests that habitat and landscape heterogeneity are important drivers for their abundance. Thus, pollination services in rice production landscapes could be conserved by enhancing the amount of flower rich habitats that provide food and nesting resources to bees.

END OF SESSION 5

Session 6 - Changing high-elevation ecosystems

CHAIRS: RAINER WALDHARDT, ANJA MAGIERA

O1 - Mountains, biodiversity and ecosystem functioning: birds as seed dispersers and arthropod predators at Mt. Kilimanjaro

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High tropical mountains offer unique opportunities to study the simultaneous effects of climate and land use on biodiversity and its ecosystem functions. We assessed bird communities in 13 habitat types with different land-use intensities along an elevational gradient from 870 to 4550 m a.s.l. at Mt. Kilimanjaro, Tanzania. We recorded several abiotic (e.g. temperature, precipitation) and biotic variables (e.g. vertical vegetation heterogeneity, biomass of invertebrate prey, fruit abundance) and used structural equation modeling to study their direct and indirect effects on bird species richness. To investigate the impacts of climate and land use on bird community composition, we analyzed their effects on avian beta diversity and its richness and replacement components. Finally, we conducted artificial fruit and exclosure experiments to study the effects of climate and land use on avian seed dispersal and arthropod predation, respectively. Climate affected bird species richness mainly indirectly through vertical vegetation heterogeneity and food availability. The impact of climate on community composition was largely explained by the loss of species at high elevations. Land-use had little impact on species richness, but profoundly changed the composition and structure of bird communities via species replacement. The strength of the land-use effect on bird community composition was contingent on climate and vice versa. Finally, a high diversity of birds was associated with an improved ecosystem functioning, both in avian seed dispersal and arthropod predation. Our results suggest that different processes drive bird diversity along climate and land-use gradients. Therefore, changes in climate and land use may have multiplicative effects on bird species richness and community composition and are likely to alter ecosystem functioning.

O2 - Baseline data for sustainable management of mountain forests along an altitudinal gradient of the Caribbean

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Site-specific vegetation data of tropical mountain forests are difficult to obtain due to accessibility. However, these data are essential for sustainable management. Our objective was to gain knowledge about (a) land use, (b) woody species richness/endemism and (c) vegetation-environment relationships in Armando Bermúdez National Park (ABNP) along an altitudinal gradient (460-3,087 m a.s.l.) sheltering the last remnants of natural mountain forests of the Dominican Republic. (a) Land use was extracted on a controlled mosaic of 295 large-scale digital color aerial photographs. Sun coffee (*Coffea arabica* var. *caturrea*) was the main cash crop planted on 0.1% of the area of ABNP, followed by various subsistence crops (0.08%). Floristic data were sampled on 137 plots, resulting in 123 woody species of 85 genera and 53 families. They were analyzed by ecological niche modeling and ordination techniques. (b) Humid broadleaf/gallery forest was the woody species-richest forest type characterized by *Alchornea latifolia*, *Beilschmiedia pendula* and *Guarea guidonea*. Lauraceae represented the woody species-richest family over the entire altitudinal gradient. Characteristic woody species in the cloud forest were *Cyrilla racemiflora*, *Clusia clusiodes* and *Brunellia comocladifolia*. The monotypic pine forest was composed of *Pinus occidentalis*. While predicted woody species richness declined significantly with elevation, endemism showed a hump-shaped curve with a maximum between 1,500-1,700 m a.s.l. in the cloud forest. (c) Annual mean temperature, annual precipitation and soil pH were the main environmental factors explaining the forest type occurrences. We conclude that the mountain forests of ABNP are rich in woody species and well preserved. However, initiating observed human impact must be controlled and monitored using the floristic and vegetation-environmental baseline data generated here for the first time of the entire mountain protected area.

O3 - Indicating resilience of mountain grassland ecosystems

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European mountain grasslands are biodiversity hotspots owing to a long history of agricultural use and biophysical constraints. However, ongoing societal changes

lead to a shift in land use practices and intensity and, therefore, threaten the preservation of biodiversity and ecosystem service provision. Currently, it is not sure how vulnerable these systems are, or whether they have developed a high resilience over their co-evolution between humans and ecosystems.

To date, current approaches measuring resilience are linked to the resilience of the whole ecosystem. However, due to complex underlying processes, external changes might influence the amount of ecosystem services without leading to considerable changes of the ecosystem. Our project aims to develop indicators for ecosystem service resilience of mountain grasslands by linking the resilience of the ecosystem to the resilience of its services. We, therefore, use indicators based on plant traits to represent management characteristics and environmental factors. By assessing the ranges of ecosystem service provision, we attempt to quantify the ranges of resilience for this service. We analysed different services related to mountain grasslands, as e.g. forage quantity and quality, or carbon storage. Furthermore, we compared these results for several management systems within one land cover type, including extensively used sites to more intensively used ones.

Preliminary results indicate that certain ecosystem services (e.g. carbon storage) show a higher resilience to land use changes than others. The ecosystem, therefore, could still provide steady amounts of its service while facing changes in the management system. In contrary, other services (e.g. forage quality) are very depending on the underlying practices, which make shifts in the management significant. For management recommendations and the adjustment of political measurements it is important to better know the boundaries of resilience of an ecosystem.

O4 - The main driving factors of the upper montane grassland diversity in the Bakuriani region (the Lesser Caucasus, Georgia)

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The main objectives of our study were: (i) to assess and to quantify the impacts of management types (pasture/hay meadow) and abiotic site conditions on the phytodiversity of the upper montane grasslands in the Bakuriani region, and (ii) to reveal the main driving factors influencing the phytodiversity of the study region. To cover the heterogeneous site conditions of the study region we sampled 146 relevés (25 m²) of different grassland types. These grassland types were derived after the k-means Cluster Analysis according to elevation (m), slope and aspect (i. e. 'Northness'). We obtained six clusters (i.e. grassland types) for wooded grassland and seven clusters for open grassland.

Detrended Correspondence Analysis (DCA) of 139 relevés (seven plots were excluded after the outlier analysis) revealed a total inertia of 3.3 with a gradient length of 2.6 SD on the first axis. The ordination graph shows a separation of relevés according to 'Habitat type'. Indicator Species Analysis supported the result of the DCA and revealed a large number of indicator species for the following grassland types: 'Wooded pasture', 'Wooded hay meadow', 'Open pasture' and 'Open hay meadow'. In a partial Canonical Correspondence Analysis 'Habitat type', 'Topography', 'Soil physical parameters' and 'Soil chemical parameters' explained 22.3% of total variation in the floristic composition. These groups of explanatory variables showed significant net effects on species composition; among them 'Soil chemical parameters' and 'Habitat type' were the most important determinants of species composition. In conclusion, low land-use intensity contributes to maintain the diversity of the upper montane grasslands in the Bakuriani region. In particular, wooded grasslands with current intermediate disturbance, due to a reduced grazing pressure may support high phytodiversity in the study area. This study was carried out within the project 'AMIES', funded by the Volkswagen Foundation.

O5 - Comparing reflectance signals of shrub species in the Kazbegi National Park to enhance monitoring of reforestation

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In the Central Greater Caucasus, particularly in the Kazbegi National Park deciduous forests once covered the slopes of the subalpine zone. However, clear-cutting and overgrazing left an almost treeless landscape. Only on the steep, north facing slopes Krummholz birch forests persisted. These forest remnants are of high conservation value and play an important role in the protection of slopes from mudslides and erosion, which are a high hazard potential for the local population.

Recent studies describe early successional stages of birch as well as encroachment process of shrub species in the region. In this context, the close proximity and gradual transition of vegetation types in the subalpine zone is challenging. Birch (*Betula litwinowii*) alternates with Rhododendron (*Rhododendron caucasicum*) (at higher altitudes), Buckthorn (*Hippophae rhamnoides*) (at lower altitudes) and tall-forb communities (near ridges or creeks). A monitoring scheme based on remote sensing applications could be helpful to assess future forest areas. Therefore, we aim to test if *Betula litwinowii* has a decisive spectral response in comparison to the co-occurring shrub and tall-forb communities.

In summer 2011, hyperspectral reflectance of *Betula litwinowii*, *Rhododendron caucasicum*, *Hippophae rhamnoides*, and *Veratrum lobelianum* were measured with an ASD HandHeld Field spectrometer. To evaluate reflectance patterns on larger scale, we used a RapidEye satellite image acquired in 2011. We additionally analyzed the vegetation composition of georeferenced vegetation relevés of an already existing database by ordination, clustering, and indicator species analysis.

Preliminary results of the current analysis indicate that the spectral differences between the tested species are subtle but characteristic. In the vegetation composition, especially the *Hippophae rhamnoides* sites are very distinct.

O6 - *Alnus viridis* encroachment contributes to excess reactive nitrogen in high montane ecosystems of the Alps

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Owing to land use decline, forests and shrubland have been expanding at the expense of centuries-old grassland in the Alps during the last decades. In particular, the nitrogen-fixing shrub *Alnus viridis* (green alder) is currently spreading at a breath-taking speed and overgrows an area of c. 1000 ha per year in the Swiss Alps. N₂-fixation by the *Alnus* symbiont *Franika alni* is expected to lead to nitrogen (N) enrichment in former nutrient poor grassland, the most likely explanation, why plant species richness is reduced, lush herb layers develop and the succession towards coniferous forests becomes suppressed across large areas of the Alps. In order to quantify these effects, we tested the following hypotheses: (1) the input of symbiotic N₂-fixation increases ecosystem N pools, and (2) N fluxes (N₂O emissions and nitrate leaching) are higher in *A. viridis* stands compared to commonly grazed pastures. Above and belowground N pools of *A. viridis* stands were indeed increased up to 10-fold. Additionally, there was a clear $\delta^{15}\text{N}$ fingerprint of *F. alni*-fixed N₂ throughout all N pools of *A. viridis* stands. Nitrogen-enriched soils under *Alnus* stands were a strong source of N₂O emissions (4.2 kg N₂O-N ha⁻¹ from mid May to late October), whereas adjacent pastures emitted 35 times less of this strong greenhouse gas to the atmosphere. Nitrate leaching was high in *A. viridis* shrubland (8 to 16 kg NO₃-N ha⁻¹ from mid June to October) and negligible in pastures. As a consequence, the topsoil under *A. viridis* stands acidifies: pH was >0.5 units lower and base saturation was 15% lower compared to adjacent pastures. These data show that N inputs by *A. viridis* are exceeding the critical load for nitrogen (CLN) by far and are reducing not only the quality of soils but are also loading surface water through the leaching of soluble N compounds and contribute to climate warming by enhanced greenhouse gas emission.

O7 - Recurrent summer droughts affect plant traits but do not alter productivity responses to drought in mountain grassland

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Extreme weather events such as severe drought periods are expected to occur more frequently in a future climate and are likely to affect ecosystem functioning. In general, grassland ecosystems are considered to be resilient to single drought events, however, little is known on how primary productivity and related plant traits are affected by recurrent summer drought. We experimentally tested effects of single summer drought versus drought recurring over 6 subsequent years on productivity, functional community composition, leaf area index, and leaf and root traits of a mountain meadow in the Austrian Central Alps. Between single and recurrent droughts there were no consistent differences concerning their effects on aboveground productivity and on leaf area index, however, mean specific leaf area (SLA) of the canopy was more strongly reduced under recurrent as compared to single drought events. Since SLA of individual species remained unaffected by drought, the observed change in canopy SLA indicates a shift in species composition, which was also reflected by changes in functional community composition under recurrent drought. Root productivity was enhanced by a single summer drought, in particular in deeper soil layers, but, interestingly, this effect disappeared under recurrent drought. Surprisingly, specific root length (SRL) of roots grown during drought periods decreased across all drought treatments, leading to reduced root length especially in the top soil layers. These results indicate that in the studied grassland drought legacy does not alter the drought response of productivity, while affecting canopy leaf and root traits and functional community composition.

O8 - Which photosynthetic strategy is more efficient in carbon sequestration on a glacier forefield?

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Since 1850 glaciers in the Alps have lost half of their total extent. On this wide area, now free from ice cover, primary succession establishes. This condition allows quantifying the role of the different plant communities in soil formation and carbon accumulation, a negative feedback to climate change. We studied the respiratory and photosynthetic pattern of two plant communities: a typical C3 grassland,

dominated by *Festuca halleri*; and a community of rocky soils characterized by the CAM species *Sempervivum montanum*.

On a Little Ice Age moraine at 2,400 m a.s.l. in the Italian Alps, during summer 2013 we continuously measured the net ecosystem exchange (NEE) using a multiplexed system (Li 8100-105, LiCor, USA) composed by 8 automated closed-dynamic chambers. Through the combined use of transparent and opaque chambers and a novel method for flux partitioning we assessed the ecosystem respiration (Reco) and the gross primary production (GPP) of the two plant communities. Carbon content in soil was analyzed by the FlashEA™ 1112 Elemental Analyzer.

The two investigated plant communities showed contrasting NEE patterns, with a large midday peak in the *F. halleri* community ($-4.83 \pm 1.32 \mu\text{mol CO}_2 \text{ m}^{-2}\text{s}^{-1}$) and two peaks, in the morning and in the evening, in the *S. montanum* community ($-1.26 \pm 0.82 \mu\text{mol CO}_2 \text{ m}^{-2}\text{s}^{-1}$ and $-0.42 \pm 0.62 \mu\text{mol CO}_2 \text{ m}^{-2}\text{s}^{-1}$), corresponding to acidification and deacidification phases of CAM plants. We performed partitioning of NEE data into respiration, that was similar for the two communities, and assimilation, that was much higher in the *F. halleri* community.

In spite of the higher assimilation, soil analysis did not reveal significant difference in carbon accumulation (2.06 ± 0.23 for *S. montanum* and $1.76 \pm 0.12 \text{ Kg C m}^{-2}$ for *F. halleri*), highlighting the relevance of processes, like gas exchange in winter and differential palatability for herbivores, frequently not accounted for in biogeochemical studies.

O9 - Seven years of carbon cycling in a subalpine pasture under N- and O₃-deposition: The soil C-sink becomes 10% larger

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We hypothesized that N-deposition would increase, and O₃-deposition would decrease the ecosystem C pool, as a consequence of their positive effect on aboveground yield and detrimental effect on gross primary productivity (GPP), respectively. The climate-interaction was expected to enhance the pollutant effect in years with favorable growth conditions.

- During the experiment average annual aboveground yield increased, independent of treatment. Yield showed strong, positive effects of weather conditions and of N-deposition, but not of O₃-deposition.

- Net ecosystem CO₂ measurements (NEE) indicated GPP to be rather insensitive against unfavorable weather conditions. Ecosystem respiration (R_{eco}), on the other hand, increased readily with increasing soil temperature, while being rather tolerant against reduced soil water content.

Consequently, whether annual net ecosystem productivity amounted to an ecosystem CO₂-sink or -source, depended on the environmental control of R_{eco} rather than on GPP.

- Bulk soil C-content increased between 2004 and 2010 by c. 10%, independent of experimental treatments. Surprisingly, the positive N-effect on aboveground yield did not translate into higher soil-C content on all treatment levels. Soil in the 10 kg N treatment had 20%, but in the 50 kg N treatment only 10% more C in 2010 compared to '03.

- Isotopic composition of bulk soil organic matter (SOM) showed more negative $\delta^{13}\text{C}$ in 2010 compared to 2003. This is indicative for large amounts of newly assimilated C in the SOM pool. In parallel with increasing soil C content, this change towards more negative $\delta^{13}\text{C}$ is also found in all soil density fractions. Again, the largest increase is in the lightest ("youngest") soil density fraction.

- Annual time courses of soil air $\delta^{13}\text{C}$ values showed a strong seasonality (>1.5 ‰). As the $\delta^{13}\text{C}$ of soil air is a proxy for $\delta^{13}\text{C}$ of the respired substrates, this is reflecting alternating discrimination processes (diffusion vs. carboxylation) in plants, during the growing period.

We conclude, that the subalpine grassland ecosystem was a C-sink in the 2004-2010 period. But the positive effect of N-deposition on aboveground yield did not translate into similar C-gains in SOM. N-deposition driven yield increases may therefore not be considered as a simple proxy for parallel ecosystem C-pool increases.

P1 - A prediction of mountain pasture grassland cover from canopy reflectance in the Greater Caucasus

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Scientists and (inter)national agencies for nature protection have agreed upon the urgent need for the conservation of Georgian mountain ecosystems. Their multiple ecological niches and human activity over the centuries have led to heterogeneous landscapes with exceptionally high plant diversity (biodiversity hot-spot). This especially applies for pasture grassland. However, in the Georgian Greater Caucasus, deforestation and following intensive sheep husbandry damaged the vegetation cover in the nearer past. Moreover, climate change and the ongoing logging of protective forestshave increasingly negative effects on soil stability and often result in land degradation that urgently needs to be halted. Hence, a regional-wide assessment of erosion starting points is essential. Remote sensing methods provide techniques to detect floristic gradients in mountainous terrain.

Hyperspectral reflectance is a promising feature to monitor erosion intensity which is difficult to detect on aerial mapping. In our study we relate vegetation cover along a gradient of land degradation to multispectral reflectance data.

This study was conducted nearby the village Mleta (1,500 m a.s.l.) in the Upper Aragvi valley of the Greater Caucasus. In 2012, we sampled 150 different 1 m² plots for their cover of vegetation, open soil and rocks, and with a handheld field spectrometer for their spectral reflectance. We used Random forest regression for the prediction of vegetation cover from canopy reflectance. Our model has a mean accuracy of about 14% with the maximum errors on highly eroded grassland. We identified the wavelengths of the red-edge spectrum to be most important for the prediction of vegetation cover. The outcomes of this study will be the basis for further large-scale research on degraded grassland.

P2 - Analysis of landscape structure and land use of the Bakuriani region (Lesser Caucasus, Georgia)

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The natural vegetation for the Bakuriani region, located in the upper montane to subalpine belt, consists of species-rich coniferous- and mixed broad-leaved-forests. However, as a result of traditional agricultural practices pastured forests and wooded meadows are the characteristic ecosystems of the today's landscape. Pastured forests have been used as common grazing areas for the local animal husbandry. In consequence the ongoing browsing damage has led to reduced natural forest regeneration and to facilitation of grassland- and tall herb-species. The wooded meadows, on the contrary, have served mainly as winter forage. To date, the spatial pattern of these ecosystems and their related vegetation is unknown in detail, but such knowledge may be important for e.g. future decisions on nature protection. Thus, a landscape structure analysis including a sampling of the dominant tree species was carried out in three steps: (1) Interpretation of ortho-images of the research area at the landscape scale in terms of land-cover and land-use (LCLU) classification. Furthermore, the canopy cover of the forests was assigned to density classes, and combined with a digital elevation model the LCLU classes were characterized by topographic factors. (2) During fieldwork the dominant tree species of selected sites were determined by visual inspection. (3) Finally, the current forest species composition was classified according to the natural vegetation types of the *Map of the Natural Vegetation of Europe* from the German Bundesamt für Naturschutz.

Our analysis clearly shows distinct differences in the spatial distribution of the pastured forest and the wooded meadows. Whereas the latter mainly occurs near

to settled areas, the pastured forests are scattered over the entire study area. The consistency of the *Map of Natural Vegetation* and the current species distribution seems to be an adequate indicator of naturalness of the canopy layer of both pastured forests and wooded meadows. The functional combination of forest and grassland management, leading to pastured forests and wooded meadows, contributes to a rich biodiversity in the Bakuriani region.

P3 - Water balance of *Kobresia pygmaea* pastures under the effects of climate change

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The *Kobresia pygmaea* pastures are the world's largest "alpine" ecosystem extending over 450 000 km² in the south-eastern Tibetan highlands. These pastures are subject to rapid land use and climate change, land use changes lead to degradation of the vegetation. Effects of global climate change on the plateau will most likely be high rates of temperature change and changes in seasonal precipitation patterns. Due to the Tibetan Plateau's important role for the global climate as the "third pole" and its importance as grazing pastures for the population, research in this fragile ecosystem is essential for future attempts to protect and stabilise it.

The present research project is part of the DFG SPP 1372 "TiP- Tibetan Plateau: Formation-Climatic-Ecosystems". Aim of the research is to measure the effects of degradation and climate change on the water balance of the *Kobresia pygmaea* vegetation. Field site of the project is since 2009 Kema Research station (4410 m a.s.l., 270km NE of Lhasa; TAR, PR China), located in the centre of the major distribution of the *Kobresia pygmaea* pastures on the Tibetan Plateau. On the study plots, a total of 85 so-called lysimeters were installed in 2010 and 2012 to monitor the water balance of the *Kobresia* vegetation. In addition, an irrigation manipulation experiment was conducted during summer 2012 and 2013, whereat gutter roofs generating three different irrigation levels (100%/control, 70% and 130% of natural precipitation) were placed above lysimeters. Within this experiment, fertilised and unfertilised *Kobresia* vegetation plots under the different irrigation levels were monitored.

From 2010-2013 (summer) data on evapotranspiration, infiltration and biomass growth of *Kobresia pygmaea* vegetation was collected.

First results from the field and the climate chamber indicate a general trend which shows that evapotranspiration and infiltration of the *Kobresia* vegetation depend strongly on the amount of water (precipitation, irrigation) available. So far, no strong difference in evapotranspiration rates between fertilised and unfertilised

plots was found. The different grazing treatments (degradation) seem to have no effect on the water balance.

END OF SESSION 6

Session 7 - Grassland biodiversity and ecosystem functioning

CHAIRS: STEFFEN BOCH, PETER MANNING, CHRISTOPH SCHERBER

O1 - Effect of plot shape and arrangement on species richness counts in grasslands

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Due to the universal distance decay in ecological similarity, the shape and arrangement of the sampling unit should affect species richness counts. By theory, regarding shape, more species should be found on elongated vs. compact units. Regarding arrangement, a sampling unit consisting of several incontiguous plots within a larger spatial extent (e.g. rarefaction curves) should comprise more species than a contiguous unit of the same area. However, effect sizes are hard to assess from the few existing studies. With our study we thus aimed at quantifying the relative differences in species richness counts resulting from varying shapes and arrangements of sampling units at different small spatial grain sizes. We used the monitoring plots of the BiodivERSA project SIGNAL in semi-natural grasslands of six Eurasian countries (FR, DE, IT, HU, BG, TR). In each of them we established six blocks of 2.80 m x 0.40 m, subdivided into 448 microquadrats of 25 cm² and recorded the vascular plant species composition in each of these. Then we calculated species richness values for different sampling unit sizes (4, 16, 64 microquadrats) for different shapes (1:1; 1:4, 1:16) and arrangements (contiguous vs. incontiguous drawn from different extents). We tested for differences by means of linear mixed models. Both shape and arrangement had highly significant effects on richness values of sampling units, and these responses were consistent across the six countries and the sampling unit sizes. Generally, the differences between squares and 1:4 rectangles were negligible while 1:16 plots showed clearly increased richness. The contiguous and the various incontiguous arrangements all significantly differed, with the richness increasing strongly with the spatial extent

from which the subplots were drawn. Our results outline the importance of taking into account design-related differences when comparing biodiversity data originating from different sampling schemes.

O2 - Landscape heterogeneity outweighs negative effects of local agricultural intensification on functional community composition

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Increased human pressure on natural systems has been identified as one of the major drivers in biodiversity loss; the associated loss of ecosystem services, such as pollination, nutrient recycling and biological control, could have dire consequences for human populations. Although the negative effects of agricultural intensification on *species richness* due to both local inputs and disturbances, and landscape-level homogenisation of vegetation types and patch sizes have been well established, the impact of intensification on *functional community composition* remains much less clear. To date, functional diversity studies have been dominated by work on plant communities, or limited arthropod taxa, such as carabid beetles, and focused mostly on local conditions. A multi-taxa dataset from a single, large-scale study under natural conditions with a landscape-level perspective offers insights not available in either smaller experimental study sites, through meta-analysis of multiple studies, or studies on single taxa.

We investigated the effects of local land-use intensity and landscape homogenisation on the functional response of arthropod communities collected under a consistent experimental design for 72 managed grasslands across three distinct regions in Germany (Biodiversity Exploratories). We identified trait syndromes for common traits across Araneae, Coleoptera, Diptera, Hemiptera, Hymenoptera and Lepidoptera associated with local and landscape intensification, and showed that although local management intensity has significant negative effects on more-specialized species, the heterogeneity of the landscape

surrounding grasslands can offset such negative effects. Species that perform the important ecosystem service of pollination are particularly favoured by this landscape-level heterogeneity, even when local intensity is high. Our results highlight that biodiversity management in grasslands requires actions at the landscape-level.

O3 - Dispersal limitation in grasslands: habitat fragmentation, land use, plant diversity and phylogenetic relatedness determine establishment success

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Dispersal limitation is an important ecological filter co-determining species richness in local plant communities, especially in the fragmented agricultural grasslands of Europe. Understanding the factors influencing the degree of dispersal limitation and the patterns of interactions between introduced species and the resident community has great relevance for community assembly, restoration ecology and the consequences of biodiversity loss for ecosystem functioning. To test for dispersal limitation, we set up a seed addition experiment on 85 grassland plots, of different land-use intensities, in two regions in Germany by adding 60-70 species to the resident community. Four years after sowing, introduction of locally novel species increased species richness by up to 30% and increased aboveground biomass slightly. The degree of dispersal limitation, calculated as the proportion of successfully established species, was affected, among other factors, by habitat isolation: establishment success was higher on more isolated plots, with a lower percentage of grasslands in the surrounding of the plots. Furthermore, species phylogenetically and functionally more close to the mean resident community and more distant to the nearest relative in the resident community had a higher establishment success. We conclude that biotic and abiotic factors, local and regional processes as well as community and species characteristics jointly determine community assembly and require more attention in restoration ecology.

O4 - Intransitive competition networks increase grassland diversity, but do not dampen the negative effect of land-use intensity on plant richness

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Intransitive competition networks, in which no species can competitively exclude all others, are a promising mechanism enabling species coexistence. However, the extent of intransitivity in natural communities, its environmental drivers and its potential to buffer negative effects of land-use intensity on biodiversity are poorly understood. We measured the degree of intransitivity in the German Biodiversity Exploratories (1500 grassland communities) and applied Structural Equation Models to investigate the potential direct and indirect (mediated through soil fertility and heterogeneity and their effects on intransitivity) effects of land-use intensity on plant species richness. Intransitive competition networks were present in over 80% of the sites studied and positively affected plant species richness. Although intransitivity increased with soil heterogeneity, as expected by previous theoretical work, it did not change with soil fertility. The contrasting effects and idiosyncrasy of the different land uses considered on heterogeneity and intransitivity (increasing with grazing and water management, but not with fertilization and mowing) obscured the potential of intransitivity to dampen the generally negative effects of land-use intensity on plant species richness. Our results provide further insights on the potential ecological processes that can be used to buffer the negative impacts of more intense land uses on grassland biodiversity.

O5 - Plant competition under root herbivory: Do plant traits explain species specific differences?

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Root herbivory influences grassland plant communities in various ways. Impacts on plant diversity are most likely triggered by shifts in competitive hierarchies that are driven by different susceptibilities toward herbivores. Wireworms are common and abundant root herbivorous pests in European grasslands and have previously been shown to negatively affect performance of different plant species differentially. To verify whether such different responses have the potential to alter interspecific competition we investigated the single and joint effects of root herbivory and competition on 12 typical grassland species in a greenhouse experiment. Our set of species was selected to functionally differ in SLA, height and clonality. As these traits are linked to plant competitive ability and possible drivers of root herbivore susceptibility at the same time, we thereby aimed to further our mechanistic understanding of plant-herbivore interactions.

Surprisingly, in monocultures all but one species were able to compensate or even overcompensate (5 species) for the effect of root herbivory in their root mass. Consequently shoot mass was not influenced by mere herbivory, except for one

positively affected species. Interspecific competition had mostly negative- or no effects on shoot- and root biomass. Interestingly, herbivory ameliorated the otherwise detrimental effect of competition on *Thymus p.*. However, all other significant interactions were negative and positive herbivore effects were, thus, cancelled out. We suggest that this arose, because herbivores were drawn to the larger root system of the competitor.

Plant traits were affected by competition as expected, but were not affected by herbivory. Herbivory and competition interactively altered relationships of root mass with height and spacer length. Explanatory power of plant traits was low, whereas more variation in root- than in shoot mass was attributed to traits.

We conclude that wireworms can contribute to species coexistence under certain conditions, but as our results are in contrast to previous findings we suggest that plant communities respond non-linearly to different root herbivore densities. Moreover, our results indicate that herbivore susceptibility is rather driven by the size of the root system than by species identity or plant traits.

O6 - Shifting plant species composition in transplanted mountain grasslands: Is it all Climate Change?

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Effects of global warming on mountain grassland diversity is highly heterogeneous over space and time. Warming simulations with manipulative approaches are indispensable for predictions but share the problem of unwanted side-effects. Transplantation to lower altitudes can be a realistic alternative in terms of vegetation period and an equal soil- and canopy- warming, however: they are both biased by methodical artifacts. In a double-transplant-experiment, grassland mesocosms were transplanted downwards along a homogeneous elevation gradient in the Central Alps (Matscher Tal, Italy) from 2,000 m to 1,500 m a.s.l., and from 1,500 m to 1,000 m a.s.l. respectively, each downward transplantation simulating a temperature increase of 2.8 K. Local and downward transplanted mesocosms were compared regarding phytodiversity species composition and aboveground phytomass.

After three years species richness did not show a reaction to any of the treatments. Downward transplanted mesocosms from the upper transplantation reacted significantly positively to warming in terms of aboveground phytomass (graminoids, legumes, herbs) but not with regard to species composition. The results from transplantation from the lower transplantation induced the opposite effect, meaning that there was no effect on phytomass but significant shifts in species composition. Using plant trait analysis, we deduced that the observed changes

were both a consequence of warming and methodological artifacts, i.e. root damage, weed species and the invasion of new species from the surrounding receiving site. At the higher transplantation, most of the (small) observed shift might be assigned to root damage, whereas at the lower transplantation effects caused by warming were more evident. To conclude a multiple transplantation approach can be appropriate to show differing impacts of warming along altitudinal gradients. However, influence of methodological artifacts increases in warmer environments.

O7 - Mesic grassland throughout Europe is surprisingly stable under drought and invasive pressure - drier sites are more endangered

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Grasslands are spatially and economically highly important for European agriculture and biodiversity. However, they might be threatened by climate extremes and invasive species. Within the SIGNAL experiment, we address stability and resilience of grassland towards extreme drought and invasive pressure across a pan-European precipitation and continentality gradient with standardized field experiments at 10 sites between Belgium and Israel. We found a surprisingly high stability towards both extreme drought and invasive species within mesic grassland, as biomass production was not reduced by a severe drought event, and as invaders were not able to spread and showed high mortality. However, we also found that drier (more southern and more continental) sites along the gradient suffered more from drought, showing losses in biomass production directly after drought, which did not persist until the end of the growing season. Furthermore, manipulation effects on diversity will be presented. Our multisite-experiment highlights a surprising degree of stability against extreme drought and invasive species in mesic grasslands. Already dry regions, however, appear likely to suffer more from climate change than moister areas.

O8 - Effects of bush thickening and chemical control on grass assemblages in a South African savanna

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Interrelated effects of herbivory and climate may promote bush thickening in savannas. The increase in density of woody species disrupts the bush/grass balance by suppressing the herbaceous layer with considerable economic implications for the farming industry. In South Africa, a popular approach to restore this balance for improved ecosystem functions and services is the application of arboricides (herbicides that kill woodies). This study investigates the condition of the grass component (density, phytomass, composition and diversity) of a savanna following bush control treatments with a tebuthiuron-based arboricide applied from an aircraft (non-selective) and manually by hand (species selective) in ranching systems of the semi-arid Molopo region.

The grass component of controlled rangelands had a significantly higher tuft density and aboveground phytomass than bush thickened benchmarks, comparable to sites under rotational grazing management. Neither the composition nor the diversity of grass species and grass functional groups differed among treatments. However, grass assemblages varied significantly in community structure, which was mainly accounted for by the abundance distribution of a few discriminating species. Grass assemblages of bush thickened rangelands were most dissimilar to those under rotational grazing and least dissimilar to those in rangelands controlled by aircraft, indicating a successional order in grass establishment with decreasing density of the woody overstorey. This was also reflected by distribution patterns of grass functional groups showing distinct responses in abundance with pioneer grasses dominating under bush thickening, a mixture of subclimax to climax species characterizing the chemically controlled rangelands, and climax species being most abundant under rotational grazing.

Results show that high woody densities negatively affect the structure of the grass component of savannas, but not necessarily result in changes of its composition and diversity. The application of tebuthiuron-based arboricides may therefore effectively restore the overall condition of the grass component, whereas the non-selective approach by aircraft creates a lack in the recovery of climax species, which might be worth considering in management decisions.

O9 - Root-hemiparasitic plants and grassland diversity: patterns, mechanisms and perspectives for ecological restoration

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Root-hemiparasites are green plants that parasitize other plants by attacking their roots and withdrawing resources from the host xylem. They represent a specialized plant functional group characterized by low-cost parasitic access to below-ground resources and ability to suppress growth of their hosts. As such, they can promote plant species coexistence (and hence diversity) by niche partitioning through introduction of an additional niche axis – susceptibility to parasitism.

Using data from the Czech National Phytosociological Database, we demonstrate, that incidence of most root-hemiparasites is indeed positively associated with high species richness of grasslands across a landscape scale. Unfortunately, most of the root-hemiparasites have retreated from the Central European landscape in recent decades, which can be attributed to land use change connected with fertilizer application and early mowing of grasslands. We demonstrate this by a series of experiments showing that root-hemiparasites are extremely sensitive to mowing in their late-vegetative and flowering period and to competition for light elevated by fertilizer application.

Root-hemiparasitic species have been suggested as a tool for grasslands restoration due to high sensitivity of competitively superior grasses to parasitism. However, the experimental evidence and practical experience have been mixed. We show that root-hemiparasitic *Rhinanthus* species are able to cause extensive harm to *Calamagrostis epigejos*, an expansive grass, spread of which represents a major threat to grassland biodiversity in Central Europe. Therefore, we suggest using the hemiparasites as a highly efficient tool for restoration of sites invaded by this grass.

Our data show that root-hemiparasites are highly relevant for grassland biodiversity. Not only do they indicate species rich grasslands, but also can act as ecosystem engineers promoting plant diversity by suppression of dominant species.

O10 - Niche differentiation and soil resource use complementarity in grasslands

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Diverse plant mixtures were found to outperform monocultures in productivity. Niche differentiation and related soil resource use complementarity among coexisting species are discussed as potentially underlying mechanisms. However, temporal and spatial dynamics of nutrient uptake of individual species within a plant community are largely unknown. We investigated the timing and spatial pattern of nutrient uptake in order to link higher productivity to higher nutrient use in more diverse mixtures. Our goal is to show that grassland species occupy different spatial and temporal niches and that niche differentiation is stronger in more diverse mixtures, leading to complementarity for multiple soil nutrients.

We used a tracer approach within the Jena-Experiment, comprising grassland plots of different plant species richness. Nutrient analogues and nitrogen enriched in ¹⁵N were applied in different soil depths in spring, summer and autumn 2011. Tracer amounts were determined in plant material harvested 48 hours after application. We investigated the effects of diversity on nutrient uptake and niche breath (Levin's B) on the community and on the species level using linear mixed effects models. Additionally, effects of functional traits were considered.

Nutrient uptake was influenced by functional group identity and functional traits, e.g. root biomass. Diversity had, however, no major effect on niche breath. Soil resource uptake differed with season, but affected all species similarly. Spatial segregation among co-occurring species could not be observed. The majority of uptake took place from shallow soil, irrespective of the diversity level.

In conclusion, even though significant differences in nutrient uptake could be observed between different functional groups, temporal and spatial resource use complementarity could not be detected. Niche differentiation may be more important under more unfavorable conditions and between more distinct life forms.

O11 - Root herbivory in grasslands by generalist insect root feeders, *Agriotes* spp. larvae (Coleoptera, Elateridae)

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Generalist root feeders likely influence plant community structure because they may preferentially feed on certain plants. However, root herbivore effects on plants may change as well as depend on the biotic environment.

We conducted several greenhouse experiments and field studies focusing on click beetle larvae (*Agriotes* spp., Coleoptera, Elateridae) as widespread, dominant generalist insect root herbivores in European grasslands. We found that root herbivores were associated with fast growing plants and fed more on plant species with large than on plants species with small root systems. Root herbivore effects on plant growth depended on the soil biota community for some plant species but not for others. Additionally, root herbivory affected plant interactions with aboveground as well as belowground organisms (invertebrate shoot herbivores and arbuscular mycorrhizal fungi, respectively), but the strength and direction of this impact varied with land use intensity on grassland sites.

We conclude that generalist root herbivores may change interspecific plant competition by feeding on the roots that are most abundant in their habitat. Their impact may be direct and/or indirect via changes in plant interactions with other organisms, and its magnitude and direction may depend on environmental conditions.

O12 - Feeding behavior of an omnivorous ground beetle in a grassland with manipulated plant diversity

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Omnivorous consumers such as ground beetles can stabilize population dynamics in food webs by adaptive feeding on several plant and prey species. Plant diversity loss, for example as a consequence of land use, can alter food web interactions on multiple trophic levels but effects on the feeding behavior of ground beetles are not well understood. We applied next-generation DNA sequencing of crop contents of the omnivorous ground beetle *Pterostichus melanarius* to directly detect species interactions. We hypothesized that high plant diversity would result in a broad diet

of *P. melanarius*. Further, we hypothesized that the diversity of microbes in the gut will increase with plant diversity.

Our study was conducted within the Jena Experiment comprising grassland plots with experimentally manipulated plant species richness. In August 2013, 15 beetles were caught in plots sown with 1, 2, 3, 4 or 8 plant species using live pitfall traps. Beetles were stimulated to regurgitate using heat-induction. General eukaryote primers in combination with 454 pyrosequencing were used to identify DNA of invertebrates, plants, and fungi in the regurgitates.

First results indicate that the number of prey species consumed by *P. melanarius* increased with plant species richness, supporting our first hypothesis. Interactions with commensals or parasites were not correlated to plant diversity. Further, we found an increase of the diversity of total taxa in the regurgitates of the beetles, including unintentionally ingested organisms like soil microbes. This might represent a generally higher diversity of species from various functional groups in plots with high plant diversity. Overall, our approach will help to deepen our understanding of consumer responses to plant diversity loss.

O13 - Pollinator responses to temperature and the effects of land use

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Response diversity is the requirement for the resilience of ecosystem functions, assuming that functionally redundant species vary in their responses to environmental conditions and thus stabilize a system. Different responses could arise for example through variable thermal tolerance. Considering that the composition of pollinator communities in grasslands is strongly affected by land use, response diversity can play an important role. Our central question is whether increasing land use decreases the diversity of temperature responses of pollinator communities and thus correspond to an impoverished resilience of ecosystem functioning against climatic variation. We surveyed plant pollinator interaction networks in grassland plots of the Biodiversity Exploratories along a land use gradient and at different weather conditions. For each of the about 500 species with a total of 15000 individuals, we described the thermal activity curves from our field data. First results show that pollinator activity is strongly predicted by temperature, and that temperature responses differ among taxa. In ecosystems with high response diversity, pollinators with a narrow temperature tolerance may be replaced by other pollinators that are less sensitive to temperature changes or have higher optimal temperatures - with positive effects on the stability of their ecosystem function.

O14 - Plant diversity induces functional shifts across trophic levels

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Human disturbances cause a loss of primary producer species richness of approximately 25% globally, and such changes in producer species richness can cascade up to the top trophic levels. Yet understanding how the process of producer species loss translates to functional consequences of consumer trophic levels remains a challenge. Species richness and other taxonomic-based measures of diversity have often been used to quantify the relation between producers and other trophic groups. While such measures are important and simple to interpret, they cannot detect variations in the functional structure of communities, namely the functional diversity.

Despite the rising acknowledgement of the importance of functional diversity, our knowledge of how functional diversity and functional trait expression of communities is affected by environmental changes remains limited.

In this study, we examined the functional diversity and composition of a broad range of invertebrate communities and trophic levels along an experimental gradient of plant species richness. We incorporated six consumer traits, relating to resource use and spatial distribution within a habitat to calculate functional diversity and composition of grassland invertebrates.

Overall, the functional diversity of carnivore and omnivore communities increased with increasing plant species richness, but not of herbivore and decomposer communities.

The herbivore community experienced a fundamental functional shift along the gradient of plant species richness. Low diverse plant communities hosted herbivore communities, which were dominated by polyphagous, chewing insects, which were equally distributed in herb and ground layer, whereas high diverse plant communities contained an equal proportion of oligophagous, chewing and sucking herbivores, which were mainly active in the herb layer.

Functional shifts in carnivore communities from low to high diverse plant communities were less strong than in the herbivore communities.

Invertebrate communities are involved in many different key processes in ecosystems as decomposition, herbivory, pollination, predation or parasitism. Hence, knowledge about the fundamental functional shifts with changing plant species richness, may allow us to predict consequences for ecosystem processes.

O15 - Aboveground-belowground food web networks properties scale non-linearly with grassland plant species richness.

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Ecosystem process rates can be sensitive to changes in biodiversity and trophic structure. The linkages in real food webs are far more complex than simplified trophic-levels suggest, but it currently remains unclear how much of the complexity is needed to maintain essential ecosystem functions. We constructed topological food web networks from 586 species collected in aboveground and belowground communities in a field experiment that manipulated grassland plant species diversity. We assessed whether particular network properties are associated with changes in grassland productivity across the plant species diversity gradient. We found that properties of combined aboveground-belowground networks were more sensitive to changes in plant species richness than networks based on either sub-system independently. Moreover, metrics that assessed species feeding interactions such as connectance and link density were more sensitive to changes in plant species diversity than metrics that assessed characteristics of nodes, such as proportion of herbivores and predators. Together these results emphasize the importance of considering terrestrial systems from a combined aboveground-belowground perspective.

O16 - Arthropod community shifts along an experimental plant diversity gradient

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Plant diversity affects aboveground arthropod communities, and there are numerous hypotheses explaining the mechanism behind that relationship. Basic patterns of community shifts have only been explored for a few diversity index showing that plant diversity positively affects both the diversity and the abundance of arthropod species. Here we extended such analyses to a wider array of methods to explore new dimensions of the relation between plant diversity and arthropod communities. We sampled arthropod communities along an experimental plant diversity gradient in the framework of the Jena Experiment and looked at plant community effects on carnivore and herbivore arthropod species. Our results confirm previous findings. Plant diversity had a positive effect on herbivore and carnivore species richness. In contrast, Shannon and Simpson diversity were not affected by plant diversity. Taken together, these results indicate that rare herbivore and carnivore species drive the higher arthropod species richness in plots

with high plant diversity. The presence of legumes and small herbs had strong effects on these diversity index, their inclusion in linear models could replace in most of the case the plant diversity effect. Species abundance distribution patterns revealed that plant diversity decreased herbivore and carnivore evenness, however the decrease was much more pronounced for herbivores. Our results show that arthropod communities are strongly responding to changes in plant communities, namely to plant diversity or the presence of particular functional groups. Therefore, the effect of plant diversity loss on arthropod communities will depend on which plant functional group are lost from the system. Moreover, in our experiment the abundance distribution became more uneven at higher plant diversity levels, indicating a higher dominance of a few arthropod species. These shifts in the arthropod community will likely affect the ecosystem function provided by these key taxa.

O17 - Drivers of spatial beta-diversity patterns in different organisms

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Beta-diversity is an important component of overall biodiversity, which is under threat from global change drivers such as land-use intensification. However, little is known about how the strength of land-use effects on beta-diversity vary between different trophic levels and how important these effects are relative to other environmental drivers of beta diversity.

Here we tested the importance of different environmental (soil, land use, landscape heterogeneity) and geographic (space, elevation) factors as drivers of the beta-diversity (species turnover) of a broad range of taxonomic and functional groups, ranging from bacteria to birds, across 150 grasslands in three regions of Germany, by using generalized dissimilarity models. We also assessed the degree of correlation between the beta-diversity (Soerensen-Index) of different trophic levels, using Mantel-tests.

We found high levels of beta-diversity in all organisms, except microbial decomposers (bacteria). Additive partitioning revealed that beta-diversity was always due to spatial turnover, i.e. species identity changed among plots, while nestedness, i.e. communities in species poor samples are a subset of communities in species rich samples, was of low importance. The drivers of beta-diversity (measured as species turnover) varied between trophic levels but, in general, geographic distance explained relatively little variation while land-use, climate or soil properties were more important. The effect of land-use intensity (combined measure of mowing, grazing and fertilization) on beta-diversity was greatest in the transition from low to intermediate land-use intensities, further intensification had little impact on species turnover (flattening of the curve). This reduction in the rate of change in beta-diversity at higher land-use intensity suggests biotic

homogenisation across most trophic levels. There were strong correlations between beta-diversities of many groups, particularly between adjacent trophic levels such as between plants and mycorrhizal fungi.

Our results identify the key drivers of beta diversity across a uniquely large range of organism groups and indicate that land use intensification causes homogenisation of diversity across trophic levels.

O18 - Land-use intensity and arthropod functional diversity in grasslands

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Intensive land use decreases diversity and affects ecosystem processes in many ecosystems, including grasslands. To understand how communities respond to land-use intensification and the consequences of such changes for ecosystem processes, trait-based approaches have been proposed.

Here we tested the effect of land-use intensification including fertilization, grazing and mowing on trait composition and single trait expression of arthropod communities (six insect orders and spiders) in grasslands in three regions in Germany. We considered 14 traits within five categories: body size, feeding, habitat use, dispersal and orientation ability. Those traits were either obtained from literature information (all species; approach 1) or morphological measurements (Heteroptera; approach 2).

Measures of taxonomic and functional diversity (functional dispersion calculated with all traits) decreased with increasing land-use intensity in both approaches. Measures of body size decreased with increasing land-use intensity, driven by a negative effect of mowing intensity. Measures of dispersal ability increased with increasing land-use intensity in both approaches. Land-use effects on feeding traits were diverse, including effects on rostrum length and shape in Heteroptera. Land-use intensity affected habitat traits, increasing the relation between body length and width in Heteroptera (thinner species under intensive land use). Measures of orientation ability increased with increasing land-use intensity in Heteroptera.

Our results indicate that not only taxonomic but also functional diversity is reduced with increasing land-use intensity. We found that smaller species, and species with better dispersal ability, are favoured by high land-use intensity. Changes in feeding and habitat traits probably reflect changes in vegetation composition, e.g. thin species are better adapted to the shape of grasses which become more important in terms of biomass with increased land-use intensity.

O19 - Functional diversity along abiotic and land-use gradients in coastal grasslands

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Biodiversity, its patterns and the principles underlying community assembly are fundamental topics in ecology and highly discussed. It is well established that plant community assembly is driven by a series of simultaneously acting abiotic and biotic filters and neutral processes. However, the relative importance of each of these processes is still unresolved. Trait-based studies form an effective way to approach the mechanisms structuring plant communities and address the above named processes. Abiotic filters are considered to lead to convergence of functional traits within a community and thus low functional diversity by sorting species with certain trait expressions (habitat filtering). Based on the assumption of limiting similarity, biotic filters in contrast are generally assumed to cause a diversion of functional traits and thus lead to high functional diversity. However, they can also cause trait convergence when a dominant species outcompetes species with contrasting traits.

Here, we take a functional trait-based approach to assessing the mechanisms that constrain community assembly in response to abiotic conditions by investigating the convergence and divergence of plant functional traits within and between communities along gradients of salinity water availability, and land-use intensity in coastal grasslands. 200 plots were located in four study sites along the North Sea and Baltic Sea coast. At each plot we recorded salinity, inundation, soil water availability, soil nutrients, and disturbance, as well as plant species frequency and form and mass-based traits.

We expected a convergence of traits at the extreme ends of the abiotic and land-use gradients mediated by habitat filtering and an increasing biotic filtering towards the more benign parts of the gradients. When only considering short section of the gradients, we expected variations in species composition to be trait-neutral.

O20 - Applying biodiversity and assembly theory to increasing extensive grassland productivity whilst maintaining high diversity

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Recent advances in plant ecology include research on concrete effects of plant diversity on ecosystem functions and processes, with a main focus on the stimulation of community productivity and nutrient cycling. Much of this experimental research has occurred in mesic relatively productive grassland habitats, and has included weeding to maintain diversity gradients. More recent work however, has started to focus on whether naturally assembling communities may also benefit from higher diversity in terms of both allowing sustained productivity as well as maintaining diversity.

Grassland productivity as well as diversity are set to become an important simultaneous goal for land managers and farmers, who are interested in increasing both productivity as well as diversity of their land. Bullock et al. (2001, 2007) sowed high and low diversity seed mixtures onto ex-arable land to restore them to species-rich chalk grasslands and found that sowing diversity significantly improved both overall productivity as well as diversity of the sites. In community assembly, the timing of arrival of different plant functional groups may affect productivity even more than the richness of species sown. My group has been testing how priority effects (species that arrive first influencing further development) of sowing different plant functional groups earlier than others affects productivity and diversity of the ensuing community. Initial results confirm biodiversity-ecosystem functioning studies in that sowing more diverse mixtures but especially manipulating the timing of arrival of different functional groups can drive further assembly and positively affect ecosystem properties. The stability and strength of different priority effects over time is now being investigated in a field experiment in Jülich called the Priority Effect Experiment.

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O21 - A non-destructive measurement of above ground biomass based on leaf area index and terrestrial laser scanning

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Biodiversity ecosystem functioning experiments in grasslands have shown a positive relationship between species richness and productivity. The complementarity use of resource (e.g. of water, light, and nutrients) among species has been suggested to cause this relationship. This includes the complementary use of light in space and time via above ground space filling by plants. We define space filling as the amount of biomass covering above ground space considering vegetation height and density. We hypothesize that more diverse grassland communities do exploit available above ground space more efficiently and over longer time periods than less diverse communities.

Because accurate measures of biomass are destructive, they do neither allow for assessing the temporal dynamics of space filling nor how it is affected by biodiversity. Here, we present a novel non-destructive method to estimate space filling (and biomass) using terrestrial laser scanning combined with leaf area index measurements. We tested the method in grassland plots exploiting the full variation of height, LAI (= density) and grass to herb ratio. Above ground biomass was measured using fresh and dry weight after harvest. Preliminary results show a strong positive relationship between observed biomass and derived space filling ($R^2 \geq 0.82$). The next step will include the analysis of the temporal dynamics of space filling and its relationship with plant functional diversity in 92 plots of the Jena Experiment.

Our method can serve as a fast and non-destructive measure to assess the effect of biodiversity on the structural complexity grassland communities and its temporal dynamics. Thus it may help to better understand biodiversity – ecosystem functioning relationships.

O22 - Root decomposition along a plant diversity gradient in grassland

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Making up as much as 70% of plant biomass, roots are the major structure of a plant. Roots play a pivotal role for ecosystem services such as nutrient retention and carbon sequestration. And yet, in contrast to aboveground biomass, we still know very little about their dynamics, particularly changes in root decomposition, in the light of biodiversity-ecosystem functioning relationships.

In our study, we aim to elucidate how plant diversity affects fine root decomposition in grassland and to disentangle the effects of root litter quality from environmental factors (including both abiotic and biotic aspects). We hypothesize that 1) root litter quality decreases, on average, with increasing plant species richness and that 2) environmental conditions favor higher decomposition with increasing plant species richness due to increasing soil moisture and decomposer diversity and abundance.

The experiment is conducted at the Jena Experiment, Germany, on 80 plots differing in species richness (1,2,4,8,16, 60 species) and functional group richness (1,2,3,4 functional groups). Our study includes three sub experiments all using a litter-bag approach: 1) decomposition of plot specific root litter in the experimental plots of the root origin; 2) decomposition of standard root litter (from *Lolium perenne*) in all plots; and 3) plot specific root litter decomposition in a homogeneous grassland plot. We measured root morphological and chemical traits as well as plot specific environmental factors (e.g. soil moisture, soil temperature, light transmittance to the ground) and soil microorganisms in all plots. Our data will provide valuable information on the effect of plant species richness on mixed root traits and environmental effects and on how these affect root decomposition in grassland. With this we will help to understand a key process of root biomass dynamics along a plant species richness gradient.

O23 - Plant diversity surpasses effects of global change factors on soil microbial biomass in experimental grasslands

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Soil organic matter (SOM) comprises the highest amount of sequestered carbon on Earth. It is estimated that about 2-4% of SOM are immobilized as biologically active microbial biomass carbon in soil (C_{mic}). Moreover, the persistence of carbon in soil organic matter is largely influenced by changes in C_{mic} . Recent research has shown that changes in plant diversity can significantly affect C_{mic} , with the strength of effects exceeding those of some global change factors such as elevated CO_2 or N-enrichment. However, testing the generality of such patterns requires the analysis of results from several experiments that have manipulated global change factors and plant diversity together. Further, recent review papers on the role of biodiversity for ecosystem functioning stressed the need for more studies on interactive effects of plant diversity and global change factors. Here, we performed a meta-analysis of 12 different studies in grassland, where plant diversity and at least one of global change factors (CO_2 , N, drought, warming and earthworm invasion) were manipulated. We show that plant species richness surpasses effects of several global change factors on C_{mic} , while effects of plant diversity were pronounced only in long-term experiments. Further, we found no significant

interactive effects between plant diversity and global change factors indicating negligible buffering effects of plant diversity on C_{mic} . Our study highlights the significance of plant diversity for C_{mic} with potential consequences for soil carbon dynamics in grasslands. Thus, incorporating the intimate relations between plant diversity and soil microbial biomass in Earth system models would improve the predictions of carbon dynamics in grasslands.

O24 - Plant diversity and functional composition mediate land-use impacts on soil carbon stocks

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Soil carbon can be affected by a range of factors, including climate, land management, plant community composition, and abiotic soil properties but the relative contribution of these to landscape variation in soil carbon stocks is poorly understood. As many of the drivers of soil carbon stocks co-vary, or are typically studied in isolation, it is difficult to disentangle their effects and estimate their relative importance. Thus, it is unclear whether the positive relationship between plant biodiversity and soil carbon storage, as reported from controlled experiments, is an important mechanism in real-world ecosystems.

We utilized structural equation modelling to understand the relationships between and relative importance of numerous drivers in determining landscape variation in soil grassland carbon stocks. This was achieved using data from a large-scale and long-term research platform, the German Biodiversity Exploratories. In 1500 grassland plots from 3 regions of Germany soil carbon stocks were measured along with numerous management factors and abiotic soil properties. Plant community data from these same plots was also used in conjunction with plant trait values from databases to generate a range of measures describing functional properties of the vegetation.

We show that soil carbon in the top soil layers is strongly influenced by land management and that these effects operate both directly and via changes to the functional composition of the vegetation. In deeper soil layers the effects of management and plant community properties are less pronounced or absent and abiotic soil properties play a relatively greater role in explaining soil carbon stocks. These results demonstrate that management of plant community composition, including diversity, can potentially boost soil carbon storage in agricultural grasslands.

O25 - High trait diversity is needed to maintain ecosystem multifunctionality

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Biodiversity loss threatens ecosystem functioning and stability. Most studies in biodiversity-ecosystem functioning (BEF) research focus on community biomass as ecosystem function. However, productivity is only one out of many possible and relevant ecosystem functions. We hypothesized that other ecosystem functions than productivity, e.g. nitrogen cycling, depend on other plant traits. Thus higher biodiversity is needed to maintain multiple ecosystem functioning than one would expect from previous productivity dominated BEF research.

We used a dataset of above- and belowground plant functional traits, covering the main aspects of plant functioning, related to the Darwinian components of fitness, i.e. growth, survival and reproduction to identify the community trait costume that maximizes multiple ecosystem functioning. We also differentiated between functional identity and diversity.

We found that ecosystem functions depend on very different trait combinations and that both functional identity and functional diversity are important.

We conclude, that the strong focus to productivity in BEF research underestimates the functional diversity, needed to maintain ecosystem functioning and stability.

O26 - A multivariate view on biodiversity multifunctionality relationships: Functional trade-offs and increased functioning at high diversity

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Can diversity simultaneously affect a wide variety of different ecosystem functions? Despite first studies having revealed stronger effects of diversity on multiple ecosystem functions than on single functions this questions remains controversial. The number of species contributing to functioning has been shown to increases with the number of studies, years, or functions considered. Yet, this often used

approach has been criticized and recent methodological advances have proposed alternatives.

Here we used multivariate statistics to investigate the relationship between plant diversity and multifunctionality based on more than 100 functions measured along a single experimental gradient of grassland plant diversity. The set of ecosystem functions included various above- and below-ground processes associated with the habitat, plants, and higher trophic levels. Using principle component analysis based on the value of each function in each of 80 plots we investigated (1) correlations and trade-offs between functions, (2) the functional fingerprint and (3) the overall level of expressed functioning of each plot and (4) the relationships of all these parameters to plant species richness.

Relationships between functions ranged from strong positive (association) to strong negative correlations (trade-off). While many functions were independent from each other. Consequently, 23 axes were needed to explain at least 75% of the variation observed in the multifunctional space. Plant diversity correlated strongly with the first principle component axis while axes of higher order did not show any relationships with plant diversity. To calculate an index of multifunctionality, we extended the “averaging approach” from single functions to a multivariate measure by summing scores for the first 30 principle component axes. The resulting index increased highly significantly with plant diversity from predominantly negative values at low diversity to positive values at high diversity. Thus, plots of high diversity supported more functions at above average levels than low diversity plots. Results from our multivariate approach are compared to other proposed approaches to measure multifunctionality.

O27 - Vegetation mediated ecosystem services in coastal grasslands: Trade-offs between nature conservation and forage intensity

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Different representative grassland ecosystems from North Sea and Baltic Sea were the focus of this study: Intensive, wet extensive and salt-marsh grasslands. Ecosystem services were independently assessed at plot level, such as forage quality, forage production and biodiversity value. We measured soil properties, environmental parameters, ecosystem properties and disturbance intensity to test

a response-effect framework which could explain the interactions and causal effects between the different services, properties, plant traits and environmental variables. The obtained results showed which environmental or ecosystem parameters were responsible for different ecosystem service provision and which situations led to and impoverishment or enrichment of the different services and potential synergies between them.

O28 - Modelling the impact of changing environmental conditions on ecosystem service provision under different climate and management scenarios

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The collaborative research project COMTESS (Sustainable coastal land management: Trade-offs in ecosystem services) investigates the impact of climate change, sea level rise and different management options on the ecosystem service (ESS) provision by coastal vegetation at the German North and Baltic sea coast. We model how disturbance events like salt water intrusion and fresh water flooding affect the hydrology of the study area, further, the composition of plant communities and hence ESS provision. A chain of hydrological, ecological and socio-economic models predicts the impact of changing climatic and sea level conditions on the hydrology, plant communities and finally ecosystem service provision of the study regions. We are developing a tool for synthesis and visualisation in order to incorporate all steps of that modelling chain which can be used for resilience as well as trade-off analyses. The resilience analysis is closely linked to adaptation and recovery times of plant communities to permanent and temporary environmental changes and the impact of these lag phases on ESS provision. But we also envision the possibility to test the influence of e.g. collapse of prices for agricultural goods, increasing costs for energy or discontinuation of subsidies. Trade-offs between single ecosystem services can be monitored over time as well as spatially explicit as maps. Valuation rules are different between stakeholder groups, another possible trade-off to be studied. Ultimately, an aggregated value for different ecosystem service groups can be compared between different combinations of several climate, sea level rise and management scenarios to inform land managers of the expected ESS provision under different environmental realities and political options.

P1 - Exploring plant community assembly for its potential for grassland restoration: the role of traits and functional diversity in assembling grasslands

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Community assembly theory is a hot topic in basic ecology and a cornerstone of ecological restoration. However, assembly processes as such are rarely directly implemented in restoration. Here, we present a series of grassland experiments that address ecological assembly within a restoration context. Our collaborative research (Forschungszentrum Jülich and the TU München) aims to improve grassland biodiversity and productivity (for bioenergy use) using priority effects as well as better understand how plant traits interact with abiotic conditions during restoration to affect outcomes.

In a field experiment, called *the Priority Effect Experiment* in Jülich we are testing the long term influence of priority effects on community development. High and low diversity mixtures were sown and the arrival sequence of plant functional types in the system was altered. The focus is on plant traits and how they affect any priority effects of who arrives first. Initial results show a strong priority effect of sowing legumes before other forbs and grasses on above- and belowground productivity.

Near Munich, the field experiment called *the N and Water Assembly Experiment* is testing the role of productivity as a driver of assembly mechanisms during the initial assembly of restored grasslands. In August 2014 we plan to also test the role of nurse plant facilitation during the assembly of this grassland across the water and N gradients.

Germination and seedling traits of all species in both field experiments have been screened to use as a guide for further controlled experiments and to compare the trait values in species growing in both field experiments.

Planned controlled experiments testing how interactions between different species change depending on which species with which traits arrive first are also highlighted.

This overall approach will help us to understand the mechanisms of priority effects in grassland communities in order to be able to improve grassland restoration as well as providing sufficient biomass for land managers.

P2 - Combined effects of drought, invasion and land use treatment in Turkish grasslands

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Multiple global change phenomena such as climatic change, land-use change and plant invasion act on the grassland systems of the European Mediterranean region. Despite the expected sensitivity of these systems, combined effects of global change have rarely been investigated so far. Here, we simulate predicted climatic changes such as drought combined with expected land use changes and plant invasions on Turkish semi-natural grassland in Manisa province in the framework of the BiodivERSA project. We simulated drought by plastic rain out shelters in the period from the 2nd/5 to the 3th/5 of the growing season. We established 18 plots (0,5 m x 0,5 m) in three control three drought blocks, respectively. For the invasion effect we planted seedlings of two invader species, namely *Senecio inaequidens* and *Lupinus polyphyllus* at the end of the drought manipulation. The land use effect refers to changes in cutting height, i.e. at 3 cm and 10 cm. We used the weight of aboveground biomass and changes in species specific cover estimates (at end of drought and end of growing season) as well as invader height-growth and number of leaves as response variables. Results on the pure and combined effects of all simulated global changes will be provided.

P3 - Studying the resilience of coastal marshlands under climate and land use change by coupling a statistical and an individual-based model

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The collaborative research project COMTESS (Sustainable coastal land management: Trade-offs in ecosystem services) investigates the impact of climate change, sea level rise and different management options on the ecosystem service

(ESS) provision by coastal vegetation at the German North and Baltic sea coast. We model how disturbance events like salt water intrusion and fresh water flooding affect the composition of plant communities and hence ESS provision. Plot-level data on species distributions, plant and ecosystem traits as well as environmental conditions is used to estimate statistical species distribution models (SDM). These models predict the habitat suitability, i.e. occurrence probability of single plant species, and are used to upscale from the plot to the regional scale. One shortcoming of SDMs is their instant response to temporary or permanent environmental changes when, in fact, adaptation or recovery times need to be accounted for. Therefore, we also use the collected data to parameterize an individual-based model (IBM) that simulates small scale resource competition applying a zone-of-influence approach. It includes the reaction of plant individuals to salt and water stress with high temporal and spatial resolution. To couple both approaches, we first let the IBM detect situations of changing environment that require adaptation or recovery time not accounted for in the SDMs (potential error). We then run the IBM with the respective input data and replace the SDMs' results until the end of adaptation or recovery of the community. Apart from improving the SDMs where their predictions are potentially wrong due to unaccounted lag phases, this method of coupling the two modelling approaches also enables us to analyse the spatial and temporal distribution of potential errors in the SDMs and the extent of actual error (i.e. difference between SDM and IBM predictions).

P4 - Salt Grasslands along the German and Polish Baltic Sea coast and the influence of wild grazing animals

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Salt grasslands are semi-natural habitats along the Baltic Sea coast which replace the natural common reed stands of low-lying areas. They have developed through extensive anthropo-zoogenic management since the 13th century. Today, they are characteristic landscape elements of the Baltic Sea coast and provide a habitat for a very specialized flora and fauna. Salt grasslands have a great importance for coastal protection as they function as a natural sea defence. Due to embankment of large areas and abandonment of the traditional management, salt grasslands have dramatically declined and the remaining fragments are endangered. While the impact of anthropogenic managed grazing is well studied, there are only a few studies about the influence of so called 'natural grazing'. This is especially of interest because in Poland, areas with salt grassland exist which never have been grazed by cattle and might have developed only because of natural grazing.

An overview of different areas will be given, considering varying management and the different vegetation types found on salt grasslands along the German and Polish Baltic Sea coast. The occurring wild animals and their influence on salt grasslands and specific plant species will be presented. In conclusion, future prospects will be given.

P5 - The role of plant functional traits and trait variation for community assembly and productivity in semi-natural grasslands

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Biodiversity-Ecosystem functioning research provided new insights of how changing biodiversity can affect ecosystem processes. These relationships were mainly investigated in artificially assembled plant communities of large biodiversity experiments. Although manipulative field experiments have the advantage to extract the causality of biodiversity-ecosystem functioning relationships, considerable debate exists about the applicability of the conclusions drawn from biodiversity experiments with artificially established plant communities to natural ecosystems. This project aims to identify the biotic mechanisms by which plant functional characteristics and their within- and between-species variation are related to community assembly and processes at the community level in semi-natural grasslands. The research sites are extensively managed semi-natural grasslands under different environmental conditions in the floodplain of the river Saale and adjacent slopes near Jena (Thuringia, Germany), where we investigate species abundances, plant functional traits and biomass production. The data recorded in this project will be used together with plant biomass, species abundance and trait data collected previously within a grassland biodiversity experiment (The Jena Experiment) for comparisons of semi-natural and experimentally established grasslands.

P6 - Clonal plants - Determinants for soil microbial heterogeneity and nutrient availability?

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Rhizomatous clonal plants are favored in fertilized environments due to their ability to rapidly occupy nutrient-rich microsites. Via nitrogen transfer between clones in subterranean runner shoots this leads to an overall homogenization of the vegetation at intensively fertilized sites. This implies that functional traits of plants,

nutrient distribution and associated microbial community are the major drivers for floral diversity at a site. In Central European grassland low winter temperatures and summer droughts are the main forces influencing both nutrient availability and microbial activity as well as abundance. We use traditionally irrigated and non-irrigated meadows in the Queichtal near Landau (Rhineland-Palatinate) as model ecosystems to study the coupled effects between summer drought, fertilization and clonal plant abundance on the microbial community and nutrient availability. Effects are studied at the within site scale (between versus below clonal plants) as well as at the landscape scale (between meadows) by a stratified combination of single samples and mixed samples in a two-factorial design.

P7 - Degraded grasslands: Biodiversity and ecosystem functioning differ between grassland types

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The highland grasslands of southern Brazil were originally used for extensive cattle farming, resulting in ecosystems of outstanding species diversity. Many of these grasslands have been transformed into tree plantations or arable land, while others have undergone management changes that aim at higher productivity (melioration) or were enforced by law (cessation of pasture burning). To which extent each of these land use and management changes alters abiotic conditions, biotic composition, and ecosystem functions compared to the original grassland state is not known. Yet a better understanding is essential for guiding conservation and restoration efforts.

We studied permanent grasslands of variable management history and intensity, and grasslands recovering from use as cropland or pine plantations, in a total of 40 sites in South Brazil. Management changes and recovery occurred over the last 2-12 yrs. We recorded abiotic conditions (soil pH, nutrients), biotic composition (vegetation, invertebrates) and ecosystem functions (e.g. pollination, decomposition). Ordination and cluster analysis showed that converted sites were distinct from permanent grasslands but that significant variation occurred also within converted and permanent grasslands. Alpha plant diversity was highest in original grassland. In meliorated grasslands and ex-arable land, soil pH and nutrient status were highest while plant diversity did not differ from unburnt and converted sites. Yet parts of this plant diversity are introduced fodder species cultivars, whose

impacts on ecosystem diversity and function are unknown. Ex-pine plantations exhibited lowest pH and soil nutrient content (especially K), species-poorest plant communities and lowest activity of belowground invertebrates. Pollinator activity was lowest in unburnt grasslands. These first results underline (1) differences between not only degraded and original grasslands but also between the different degradation types and (2) the importance to assess multiple ecosystem traits and functions on different trophic levels to evaluate degradation stages for conservation and restoration.

P8 - Changes in ecosystem functioning of coastal grasslands depending on environmental parameters and disturbance intensities

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The coastal wetlands of the North Sea are characterized by relatively large tidal amplitude and a higher salinity level than the habitats of the Baltic Sea coast, where tidal influence is low or negligible. Such differences have a major influence on the plant species diversity, biomass production and nutrient cycling in these areas. In addition, land management has a high impact on the vegetation performance.

In this complex study the effects of environmental parameters and land management and its influences on ecosystem functions of coastal brackish and freshwater grasslands along a strong salinity and disturbance gradient were analyzed.

On 200 plots along the coast line of the Netherlands, Germany and Denmark, plant species responses to environmental conditions and disturbance regimes in coastal and fresh-water wetlands (brackish and freshwater meadows and grasslands) along humidity, salinity and disturbance gradients were measured. On all plots, vegetation parameters as well as decomposition rate, groundwater level, groundwater salinity, soil parameters and disturbance type and intensity were determined.

Corresponding to salinity as a strong environmental filter in the assemblage of plant communities, we found that species diversity decreased with increasing groundwater salinity. Further, we indicate increasing primary productivity with rising disturbance intensities in managed areas due to increasing use of fertilizers.

END OF SESSION 7

Session 8 - Biodiversity patterns and human impacts in mediterranean landscapes

CHAIRS: MARTIN SAUERWEIN, NICO HERRMANN

O1 - Research in the National Park Asinara (Sardinia, Italy)

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The Mediterranean Region is one of the 25 biodiversity hotspots of the world and the most species-rich area of Europe. Since biodiversity is threatened by an increasing pressure of land use and climate change, conservation areas like National Parks have an important role in protecting this remarkable species richness.

The island of Asinara (52 km²) is located in the northwest of Sardinia. In the past Asinara was used as pasture land and later, for more than a century, as a prison island, autonomous with an agricultural colony. Asinara is nowadays an important cultural and natural heritage. In addition to the high diversity of plants, the island of Asinara also exhibits a variety of grazing animals, consequence of its former land use. The number of domestic animals, left behind from the prison-time, increased thus influencing the environment. To preserve this particular ecosystem the National Park Asinara was founded in 1999 and in 2003 the island's marine ecosystem got protected.

For conservation and management implementations in the face of the ongoing global change, research on the functioning and development of the ecosystem is essential. Therefore, the National Park has given the possibility to carry out scientific research in different areas like botany, zoology, ecology, geology and climate research. However, studies are not only performed towards conservation ecology, but also in archaeology, anthropology and economy.

In the last years studies on the biodiversity of the island has been intensified through collaboration with several national and international Universities and institutions. Recent projects are for example, the malacofauna of the marine area, mapping the composition of the sea bottom and the biodiversity of vascular plants. This research and among others is fundamental for integrating ecological knowledge into nature conservation and ecosystem management, especially in a young developing National Park like on the island of Asinara.

O2 - Land use and distribution of grazing animals in the National Park Asinara (Sardinia, Italy)

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Environments throughout the world are being altered by humans. In many regions, the increase of human needs drive water quality and soil fertility to degradation, and dissect, deplete, and endanger ecosystems. Land use is one of the major factors endangering biodiversity and is performed in various ways such as agriculture (in particular grazing), forestry, and settlements. The knowledge of historical land use and its effects can be applied in order to maintain and restore ecosystems and to develop sustainable land management.

On the island of Asinara (Sardinia), a diversity hotspot regarding especially the flora, land use has affected the landscape for decades, for example, by intensive agriculture and animal husbandry while being a prison island. Nowadays, Asinara is managed as a National Park with free ranging grazing animals like mouflons, wild boars, donkeys, horses, and goats (the last three were released after prison time).

The landscape context (e.g. geomorphology, hydrology, vegetation cover) has an impact on the distribution, activity and composition of fauna and flora. Thus, we study the interrelation between the distribution of grazing animals and the landscape context of the island to understand the pattern of their distribution. We assessed the distribution of grazing animals via a combination of point- and line-transect monitoring and have explored differences in their distribution. Our preliminary results show differences in the occurrence of the grazing animals indicating seasonal and topographical preferences. For example, horses are observed in the southern plains (former agricultural areas), while mouflons have seasonal local occurrences.

In our further research, we aim to identify the interrelations of the distribution of grazing animals to the structures of historic land use and the current landscape context. Based on this research, we will derive recommendations for the sustainable development, management, and protection of the National Park.

O3 - Occurrence and activity patterns of bats in different habitat types in the northern part of the island of Asinara (Sardinia, Italy)

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The Mediterranean region is a biodiversity hotspot for bats in Europe, which are subject to a high risk of habitat loss due to the diverse anthropogenic impacts. This increases the need for targeted conservation efforts in these endangered species. To initiate conservation measures it is essential to identify the most important sites for hunting and roosting. Protected areas like National Parks play an important role for the conservation of suitable habitat structures.

The Italian island and National Park Asinara is characterized by low vegetation shaped by a large number of grazing animals and includes many abandoned buildings from former settlements. Apart from a small area, no forested areas are present. To analyze if and how bats use those particular structures, we studied the abundance and activity patterns of bats in habitat types defined by vegetation, and spatial structure ("forest", "semi-open", "open" and "settlement"). For each habitat type, three representative study sites were selected, and bat detector recordings were done from June to August 2013. Simultaneously we collected insects at these sites to study if bat activity correlated with the amount of prey.

We identified eight species in the study area, including many recordings of the endangered *Rhinolophus hipposideros*. Bat activity in terms of bat passes, and social calls, was very high at all study sites. Activity was higher in "forest" and "settlement" compared to the more open habitats. There was no effect of prey amount or abiotic parameters on activity. In contrast, feeding activity, determined by feeding buzzes, was influenced by prey amount but independent of habitat type.

Thus bats preferred certain habitat types and adapted their hunting behavior to prey availability. Although the most affected habitat type "forest" covers only a small area of the island, the high bat activity and number of species in the whole study area on Asinara emphasizes its role for implementing the habitat directives (NATURA2000) for bats in Europe.

O4 - Modelling species distribution in a Mediterranean diversity hotspot

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The island of Crete is one of the biodiversity hotspots in the Mediterranean, and as the 5th largest island in the region, it holds a variety of abiotic gradients. In its

southeastern parts semi-arid conditions prevail - in contrast to the humid northwest. Its climatic gradients, extreme relief, the variety of geological substrata, together with a long land use history, result in a highly diverse flora of more than 1800 vascular plant species. Although explored for a long time, many parts of the island are hardly accessible and some plant distributions remain unclear.

Using a floristic database with 650.000 records, we show observed and modelled potential distribution patterns. We used modelling software and combined several abiotic and anthropogenic parameters with point data of species records. The software output is a probability map for the species distribution.

We compare the observed distribution of species and their probability of occurrence. Naturally rare species are often occurring in isolated mountain sites or cliffs. If the modelled distribution due to environmental factors is much wider, area restrictions might be the result of e.g. dispersal limitations or competitive effects. Species of wet and sandy habitats in the coastal areas, are endangered by expansion of touristic infrastructure and abandonment. Our results address areas in conflict with conservation and urbanization and show differences between potential and actual vegetation cover.

O5 - Are there congruencies in the diversity patterns of six different taxa along the climatic gradient in Israel

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Israel is situated at the crossroads of Africa, Asia and Europe and well known for its high species diversity. Further, Israel is characterized by a steep gradient of climatic conditions resulting in rich habitat diversity at regional scales. In order to assess whether the diversity patterns of different taxa react similarly to climatic conditions we collected species data of six taxonomic groups – ground beetles, weevils, darkling beetles, ants, scorpions and vascular plants – from 27 different sites (3 levels of mean annual precipitations by 3 levels of mean annual temperature and 3 replicates each).

Invertebrates were collected by 6 pitfall traps per plot opened 4 catching seasons in 2010/11 resulting in more than 100 trapping days per trap and plot. Surrounding vegetation was surveyed in the respective flowering seasons. Alpha diversity patterns were evaluated using spearman-rank correlations. Congruencies in beta-diversity (Sørensen index matrices for binary species data or euclidian distance

measure for metric data) were tested by using Mantel tests and matrix regression models.

We recorded almost 1000 species of the 6 taxon groups. Patterns of cross taxon species richness (alpha diversity) were highly variable among taxa and study site. On the level of alpha diversity only patterns of weevils and vascular plants were significantly correlated. In contrast, beta diversity patterns (species turnover) are explained by differences in abiotic factors. Moreover, the beta diversity matrices are highly correlated between the different taxa.

Our study confirms that beta-diversity is an important aspect of species diversity.

O6 - Understorey vegetation in a forest restoration experiment in Mediterranean Chile: competitor or facilitator?

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Native forests of the coastal area of Mediterranean Chile have been widely replaced by *Pinus radiata*-plantations. In particular, the diverse Coastal Maulino Forest with the endemic *Nothofagus glauca* as the dominant tree species has been affected. Today, only fragments of this forest type are left within a matrix of plantations. Although plantations will remain dominant, a restoration of the native forest might be an interesting management option for some forest owners in light of biodiversity aspects and ecosystem functioning. Knowledge on restoration measures, the restoration potential of pineplantations and the effects of understorey vegetation on tree regeneration is, however, scarce.

We investigated the understorey community composition of four different management variants planted with native tree species (*Nothofagus glauca*, *N. obliqua*, *Quillaja saponaria*) in a private forest area - (1) clear cut of a mature *P. radiata*-stand (0.5 ha); (2) a 25 x 200 m strip cut of a *P. radiata*-stand receiving shade from adjacent plantations; (3) young *P. radiata*-trees functioning as nurse plants for the planted native trees (0.5 ha); and (4) thinning of a dense around 25-year old *Nothofagus glauca* forest as an example for a possible management of small native forest remnants (0.5 ha) – and contrasted results to surveys conducted in a nearby 200 ha unmanaged native forest. Correlations between understorey biomass and growth of planted tree species should reveal a competing or facilitating effect on tree regeneration.

The clear cut differed most from the native forest community and showed the highest mortality of planted tree species (80%) probably due to the rapid expansion of alien species. On the other variants though, the effect of the understorey biomass on tree growth was mainly neutral or positive. The proportion of endemic

and characteristic forest species was > 20% indicating a restoration potential of these management variants for a native forest community.

P1 - Plant diversity on Asinara island (Sardinia): Ecological factors and restoration potential

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The Tyrrhenian islands in the Mediterranean region are considered as a biodiversity hotspot containing the highest plant diversity in all over Europe. Today, unsustainable land use coupled with climate change is a severe factor threatening this diversity. Due to its former use as pasture, sanatorium and agricultural penal colony, the small Italian island of Asinara (52 km²) in the northwest of Sardinia was widely influenced by grazing, farming and raising of livestock. After becoming a National Park in 1997 the land use systems were abandoned, leaving a distinct landscape with an exceptional high biodiversity (about 700 vascular plant species), extremely valuable for nature and culture conservation.

As a part of the interdisciplinary research group 'Influence of grazing, pedosphere, relief and climate change on the biodiversity of the National Park Asinara (Sardinia)', we studied abiotic as well as biotic factors, which have shaped the vegetation structure of the island for a long time. In total, we analysed on 65 plots (each 100 m² in size) the distribution, plant composition and structure of the main habitat types. Vegetation surveys in spring and late summer were combined to obtain the whole range of species at the studied sites. To estimate the strong influence of grazing, we carried out an extended approach and examined another 23 plots with very high grazing intensities at wet and dry sites. In correlation with environmental parameters, several plant traits that are known to be affected by grazing were recorded. In order to assess the restoration potential of disturbed areas and its value for biodiversity, a soil seed-bank analysis was performed.

In cooperation with the National Park authority, the results of this project should contribute to the management and maintenance of this young National Park, considering measures like the regulation of feral animals of domestic species and the conservation and restoration of the diverse native flora, also in view of a future climate change.

P2 - Soil geography, site properties and resulting ecosystem functions and services in the National Park of Asinara (Sardinia)

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Mediterranean ecosystems have been used by humans since ancient times and therefore are often degraded, especially regarding to soil erosion and vegetation change. To use these systems adequately and avoid further negative effects on their functions and abilities, information about the pedological properties is of high importance. In this interdisciplinary project site properties and soil formation all over the formerly (until the end of the 20th century) intensively used Mediterranean island Asinara (52 km²) are assessed in different habitat types. Via combining the soil data with vegetation surveys, connections between soil and plant species composition of the sites are studied and especially the role of ecosystem functions and services provided by the soils will be identified. In addition to pedological analyses of soil profiles and drilling cores, laboratory analyses are done to identify physical (e.g., soil texture) and chemical (e.g. pH, CEC, Corg) values. To include the substrate genesis, as an important factor for soil development and site potential, and the influence of the relief intensity in the study area, toposequences (catena) are established. On the bedrock, which is dominated by magmatic (granites) and metamorphic (gneiss and mica schists) rock, predominantly Leptosols, Cambisols and Luvisols can be found. The site properties (chemism, water supply) are determined by the bedrock and the resulting weathering susceptibility, landform ensemble, substrate genesis and moreover historical land use (anthropogenic sedimentation). Based on these requirements and processes ecosystem functions and services arise. The assessment of the only formerly used (e.g. provision of water and nutrients for the vegetation) and current (e.g. carbon storage, water purification, cultural/historical services) ecosystem services allows to develop a transferable methodology for other regions and to underline the role of conservation areas in the ecosystem services concept.

P3 - Phytodiversity of the National Park Asinara, Sardinia - Forest habitats as a goal of restoration?

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The Mediterranean region is characterized by a high biodiversity. In particular the Sardinian flora consists of 2400 species from which 5% are endemic. Here, topographic differences and the influence of grazing animals are often the main reasons for this high phytodiversity. The island of Asinara in the northwest of Sardinia disposes with its 52 km² 700 plant species. Asinaras former use as pasture, agricultural colony and prison has caused the utilization of wide areas and the introduction of plants and animals. As a result a mosaic of open and half-open habitats has evolved and the natural dominant vegetation type, *Quercus ilex* forest, was suppressed into a small area. The aim of this study is to compare plant diversity of open and half-open habitats with closed forest habitats to draw conclusions for the management of the National Park. In addition correlations between soil, site conditions and plant traits are done. Therefore, the vegetation was assessed with a total of 27 plots, each of 100 m². The habitats were chosen from a line of succession: open coastal vegetation, two half-open types and three forest types consisting of *Juniperus phoenicea*, *Pinus pinea* and *Q. ilex*. First results show that the number of species from half-open habitats exceed the open and the closed habitats. The endemic flora is nearly limited to the open and half-open vegetation types. Therefore, these habitats have a high value for the diversity and conservation. Otherwise, forests with *Q. ilex* are a priority habitat of the Habitats Directive. It provides habitat for several animals and is also an ecosystem which is under threat since roman times and therefore worth of protection. Therefore, a restoration of the *Q. ilex* forest is important but shouldn't interfere drastically with the half-open habitats. First steps should be done around the few scattered habitats. Additionally, rejuvenation should be supported through reduction of introduced grazing animals.

P4 - Ecological observations on Turkish stenoendemic *Arenaria speluncarum* McNeill

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Turkey has very rich flora with about 11700 vascular plant taxa. Taurus mountain range is one of the most important plant areas in Turkey and harbors many stenoendemic taxa. *Arenaria speluncarum* is an endemic species only known from Kamlı Dere in the Central part of Taurus range. In this study, the morphological

description of the species was expanded. The habitat features and accompanying taxa of this species were determined and presented. In addition, the actual and potential threats on the known population were recorded according to our field observations and threat category of the species was updated based on IUCN criteria.

P5 - Flora of Balkusan Valley (KARAMAN)

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This research was carried out to determine the flora of Balkusan valley. The research area is in the C4 square according to Davis's Grid system. The study was conducted between 2010 and 2012, during which time 789 plant samples were collected. At the end of evaluation of plant samples collected from the field, 461 taxa, as 262 genera, 455 species, 2 subspecies and 4 varieties belong to 62 families, have been determined. 93 of these taxa are endemic and endemism ratio is 20,2%. The distribution of taxa within the phytogeographical regions was as follows: Mediterranean elements 99 taxa (21,5%), Irano-Turanian elements 100 taxa (21,7%), Euro-Siberian elements 13 taxa (2,8%) and widespread and others which their regions unclarified are 249 taxa (54%).

P6 - Employment of inula (*Dittrichia viscosa* L. (W. Greuther)) for biological pest control

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Dittrichia viscosa L. (W. Greuther) is a herbaceous perennial Mediterranean plant. It occurs naturally in ruderal environments and is an important natural food source for caterpillars of butterflies and moths. Many insects feed on the *D. viscosa* plants who provide plant sap for growth and development. In its natural range, it is also the host plant of efficient predators such as the mirid bugs of the genus *Macrolophus* or beneficial insects which control the olive fruit-fly. In some Mediterranean agro-ecosystems it has been therefore employed to enhance the presence of a high insect biodiversity and to reduce the number of pests in crops. Its peculiarity to attract and feed the caterpillars of predatory insects, and because of its wide range tolerance to environmental stresses, it may be potentially suitable for biological control in the Mediterranean region.

END OF SESSION 8

Session 9 - Biotic interactions in complex landscapes

CHAIRS: EMILY MARTIN, EMANUEL FRONHOFER

O1 - Landscape-scale interactions and natural pest control: from empirical observation to theoretical elucidation

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Natural pest control is an important ecosystem service that depends both on the presence of the natural enemies of pests, and on the interactions occurring among enemies and between enemies and pests. In a landscape-scale field experiment on cabbage plants, we tested the influence of landscape complexity (as % seminatural habitat) on the interactions between guilds of natural enemies, and on the degree of final pest control. We found that in complex landscapes, antagonistic interactions between vertebrate predators and flying insects led to herbivore release and lower pest control than in the absence of vertebrates. However, in simple landscapes, vertebrate predators appeared to contribute directly to herbivore suppression and increased pest control.

In order to elucidate what mechanisms may have led to this empirical result, we used a modelling approach to simulate the effects of intraguild predation by vertebrates on flying insect enemies, for herbivore populations across a gradient in environmental heterogeneity. We found that with increasing amounts of seminatural habitat, and/or with decreasing spatial autocorrelation of the landscape (increasing configurational complexity), intraguild predation by vertebrate top predators on flying insect enemies indeed led to a release of herbivore populations. However, this effect was shifted in homogeneous landscapes to a direct effect of vertebrate top predators on pest reduction, in agreement with previous empirical results. This shift in the effects of intraguild predation on pest control is explained in our model by differences in the local stability of mesopredator (flying insect) populations across landscapes. These theoretical results have implications for further empirical studies of predator-prey interactions across landscapes and for applied management strategies to improve natural pest control services at large spatial scales.

O2 - Linking community genetics and metacommunity ecology in plant-insect systems

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Two different, yet complementary, approaches in the study of species interactions have recently received increased attention: community genetics and metacommunity ecology. These two areas have often been studied independently but we suggest there is much to gain when considered together. Whereas there is now a vast amount of literature in community genetics showing that plant genetic variation influences associated animal and plant community structures, there has been little work concerning spatial processes on this. Indeed, community genetics studies are often conducted on dominant plant species, which are inherently fragmented and can support a metacommunity system. Metacommunity ecology is still relatively theoretical with field studies only weakly relating to the theoretical paradigms. We present results showing how we can bridge these two areas in order to study metacommunity ecology under a community genetics framework. This is especially relevant to plant-insect communities, where plant host is a natural local community. Our main research system involves the aromatic tansy plant (*Tanacetum vulgare*), its specialised aphid species and their natural enemies. By combining these two areas (into metacommunity genetics) we aim to show how within-species genetic variation can drive metacommunity dynamics across a spatially heterogeneous habitat.

O3 - Modelling food webs in patchy landscapes - species interactions, dispersal and landscape dynamics

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We have been developing a general stochastic model of food web dynamics in patchy landscapes. Our approach merges three research programmes: metacommunity theory, food webs and dispersal. Metacommunity theory has revealed connections between landscape structure, local species richness and beta diversity. However, it has focused almost entirely on communities of competing species, without considering interactions across multiple trophic levels. On the other hand, food web theory has focused mostly on interactions within one site. The third ingredient for our food web metacommunity model is dispersal among local communities. Despite evidence of the dependence of dispersal abilities on species traits, such as body size, and density-dependence of emigration and immigration, studies within the metacommunity framework focused mostly on a competition-colonization trade-off. We include more realistic dispersal process depending on species traits and abundance. The way our model couples local and regional processes provides an opportunity to gain better understanding of regional-scale structure and temporal dynamics of complex ecological communities. We illustrate the potential of our approach by comparing the responses of metacommunities with different trophic structure to habitat

clustering and disturbances.

O4 - Removal of a single ant species leads to dramatic changes in the structure of an arboreal arthropod community

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While the role of predation as a structuring force in communities is undisputed, closely related prey and predator species are often assumed to have the same role and are thus pooled into guilds as study units, though this conflicts with ecological reality. Focusing on ants as dominant generalist predators in arthropod communities, we set up an ant-exclusion experiment in the canopies of an organic citrus grove and we examined its species-level impacts on psocopteran, aphid, spider, heteropteran and beetle assemblages. Our aim was to isolate the effects of the ant *Lasius grandis*, a predator and aphid tender, from the rest of the ant community and to quantify its effects on species assemblage composition and on species densities in each considered arthropod group. We established the treatments “No Ants” (glue band excluding all ants), “*Lasius* only” (glue band plus tubes allowing only *L. grandis* to reach the canopies), and “All ants” (canopies with natural ant densities). We found that the sole presence of *L. grandis* exerted a strong effect on species assemblage composition in all arthropod groups, and on species densities in all groups except psocopterans, whose species densities were only affected by the “All ants” treatment. In general, *L. grandis* exclusion led to a 2-3-fold increase in population densities of the affected species, both carnivorous and herbivorous, while densities of aphids underwent strong reductions. However, our analyses also revealed contrasting responses to *L. grandis* presence in closely related species: within each group there were species unaffected by the “*Lasius* only” treatment that were instead affected by the “All ants” treatment, and vice versa. Our results show a distinctive and widespread influence of *L. grandis* on the structure of the arboreal arthropod assemblages and highlight the crucial importance of species-level analyses in community ecology.

O5 - Is pollen limitation a barrier to invasion?

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The introduction and spread of alien species alter native communities and ecosystems. Therefore, what drives invasiveness of alien species is a timely question in ecology. The successful establishment and persistence of an alien

species in non-native regions depends, at least partly, on its ability to reproduce. As many plants were introduced in non-native regions without their usual pollinators, it is likely that they are limited by pollinator and mate availability. We tested whether pollen limitation, driven by pollinator and mate limitations in the new environment, is an important constraint to plant invasion. In a common garden experiment, we assessed the degree of pollen limitation of 10 triplets of confamilial native, invasive aliens and non-invasive alien species using a pollen-supplementation experiment. We additionally assessed the degree of autofertility of our plants, using a pollinator-exclusion treatment. Our preliminary results show that native plants were pollen limited but the aliens were not. However, there were no significant differences in the degree of pollen limitation among native, invasive and non-invasive aliens. Furthermore, overall plants were autofertile but there were no differences in the degree of autofertility among our three groups of species. Our findings support others that alien plants are able to build associations with resident pollinators or self-fertilize in non-native regions. This may have helped them establish and ultimately spread. However, in our study, non-invasive aliens were not more pollen limited than invasive aliens. Therefore, these results do not support our hypothesis that pollen limitation may play a central role in plant invasions.

O6 - Using Bayesian Estimation of Spatial-probit-Models to analyze neighborhood relations of Red Kite in the cultural landscape of the Wetterau

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The composition of the Wetterau county, a cultural landscape of the German federal state of Hesse, intensively depends on the functioning interplay of the biodiversity, human interplays and the landscape matrix. In this landscape, the Red Kite (*Milvus milvus*) is an umbrella species, that is of major importance for the local trophic structure and for nature conservation. In the last decades, distributions of Red Kite have suffered partly dramatic declines and fluctuations. With the habitat traits, that the Red Kite needs, open and semi-open habitats with small and medium groves, landscape elements and large proportions of close-by arable and meadow areas, the Red Kite has complex requirements, which surely stand under an enormous pressure of adaptation. How exactly these habitat traits are assessed is also a question of the neighborhood relationships, as seen in a quantitative way. We set up a spatial probit model to understand the variation in individual choices, which the Red Kite individuals exerted when moving between different cells of land use in the cultural landscape of the Wetterau. We used Bayesian estimation of the spatial probit model to analyze the neighborhood

conditions and used it to explain the deviance of true specimen locations from the theoretical expectations. The consequences of possible nature conservation action items are discussed.

P1 - Dendritic network structure and dispersal affect temporal dynamics of diversity and species persistence

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Landscape connectivity structure, specifically the dendritic network structure of rivers, is expected to influence community diversity dynamics by altering dispersal patterns and subsequent species-interactions. Comparative and experimental studies, however, have been studying diversity from an equilibrium perspective. We experimentally tested the effect of dendritic versus linear network structure on temporal dynamics of diversity, using microcosms that allowed for active dispersal. Additionally, we compared these results to metacommunity models with neutral dynamics, variation in carrying capacity and a competition-colonization trade-off. We found that diversity patterns were driven by the interaction of dispersal and network structure and by local species interactions. Our results for the first time show that the characteristic dendritic network structure may not only cause, but also maintain diversity patterns across many generations. Importantly, however, diversity showed temporally dynamic patterns, indicating that the consequences of dispersal and species interactions unfold differently in dendritic versus linear metacommunities over time.

P2 - Societal Relevance of Biotic Interactions: A New Conceptual Framework Based on the Concept of Ecosystem Services

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Ecosystem functions are merely supported by biotic interactions. Both, mutualistic and antagonistic interactions play a key role for generating and maintaining biodiversity and sustaining the stability of ecosystems. Insofar, ecosystem functions provide goods and services that satisfy human needs. In recent years, ecosystem services became an expression to highlight the major societal relevance and importance of ecosystem functions for human well-being.

Additionally, threats by global environmental change for ecosystems worldwide, and thus for biotic interactions, are increasing during the last decades. But until now, the societal relevance of biotic interactions in the context of environmental change has rarely been addressed. Focus of recent studies is often on the relevance of specific global change drivers that may affect biological communities. While it is recognized that biotic interactions can be highly responsive to environmental change, a systematic framing of the societal relevance of biotic interactions is missing. But such a framework may be of major importance to capture the consequences of environmental changes on human well-being.

This presentation seeks to identify the links between biotic interactions, ecosystem functions and human well-being under current environmental change. Against the background of empirical results on the interaction of climate change and other drivers affecting (mutualistic and antagonistic) biotic interactions, we developed a conceptual framework illustrating their societal relevance. It is based on the concept of ecosystem services and gives indication of the role and contribution of natural processes to human well-being. Through the application of the framework, we deduce implications for society and advise future research directions.

P3 - Responses of insect herbivores to habitat fragmentation: a meta-analysis

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Insect herbivores are recognized as an important component of all ecosystems as they can impact plant growth and reproduction, thus affecting plant community structure and diversity. Several studies have evaluated how herbivore species richness and abundance as well as plant damage by insects are affected by habitat fragmentation. In general they found that habitat loss and habitat isolation decreases species richness and density of herbivores, and consequently reduces insect herbivory. However, other studies have shown the opposite trend or did not find any significant relationship. In addition to direct effects, indirect top-down as well as bottom-up processes can be expected to change with habitat fragmentation. Small fragments support fewer plant species and thereby, reduced associated resistance, potentially leading to higher herbivore and herbivory levels. Since natural enemies, which may control herbivore populations, can be more vulnerable to fragmentation than herbivores there. Here we test in a meta-analysis the effects of habitat fragmentation (fragment area, isolation and fragmentation per se) on abundance and species richness of herbivores and on herbivory levels. We considered insect herbivory at the plant species levels, but also the community level. In the course of a systematic review we found 82 suitable studies evaluating the effects of habitat fragmentation on abundance and species richness of herbivores and on herbivory levels in a range of ecosystems: ranging from tropical forests to grasslands. Across all studies, habitat fragmentation had a negative effect on insect herbivory. This result indicates that reduction of species richness and density of herbivores is more driven by direct effects of habitat fragmentation than by indirect bottom-up or top-down effects. Our meta-analysis can provide a better understanding of the responses of insect herbivores, and the process in which they are involved, to landscape modification.

P4 - Towards Metacommunity Genetics - Aphids on Tansy

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Mechanisms structuring local ecological communities are for the greater part unknown, due to the complexity of ecological systems. Many studies have approached this issue either from a community genetic or a metacommunity

ecological point of view, which both independently study species interactions. However, a combination of both may provide further insights into the mechanisms that structure local communities. In our research, we use a metacommunity genetic model system to understand how genetically-based traits in plants and insects can influence species interactions and metacommunity processes. This system is based on the aromatic plant tansy (*Tanacetum vulgare*) and its specialized aphid species (*Macrosiphoniella tanacetaria* and *Metopeurum fuscoviride*) as well as associated aphid-tending ants, parasitoids and predators. These aphid species exhibit a classical metapopulation structure, with limited dispersal between plants and frequent extinction events followed by colonization by winged aphid morphs. We present results from a field study on this system where aphid sub-populations, and their associated community of ants and predators, were observed throughout the season on 180 individual plants. We aim to understand the aphid distribution in terms of local species interactions. Furthermore, tansy is known to vary in the terpene-based volatile organic compounds they contain, which lead to “islands” of different chemotypes in the field. This could influence metacommunity dynamics through changing plant-insect interactions e.g. preference and performance of aphids and associated species. Thus, we will also characterize chemotypes of individual plants by using GC-MS. Future work will include next-generation sequencing (NGS) approaches to identify SSRs and SNPs for population genetic analysis both in tansy and aphids, as well as providing the tools for the synthesis of chemical and genetic data.

P5 - Environmental gradients determine seed removal of Swiss stone pine (*Pinus cembra*) across its elevational distribution

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The regeneration of many plants depends on plant-animal interactions, such as seed dispersal, or seed predation. The way animals interact with plants may, however, strongly be determined by environmental conditions. To understand a plant's regeneration potential across its distribution, it is important to consider local environmental gradients affecting these biotic interactions. In this study, we investigated an important biotic interaction for plant establishment, post-dispersal seed removal. Many animals, such as rodents, pilfer dispersed seeds and thus, shape the regeneration of plants. We studied the effects of different environmental variables on post-dispersal seed removal of an alpine tree species, the Swiss stone pine (*Pinus cembra*). We conducted seed removal experiments across the entire elevational distribution of the pine in the Swiss Alps. We experimentally deployed seeds in caches underneath the soil surface, to simulate seed caching-behavior by the pine's most important disperser, the Spotted nutcracker (*Nucifraga*

caryocatactes). We investigated seed removal patterns across the pine's elevational distribution and tested how micro-environmental variables, such as canopy openness and dwarf-shrub cover shape seed removal. Camera traps were used to identify the seed-pilfering community. Across the elevational distribution of the pine, seed removal rates and seed predator abundances significantly decreased with increasing elevation, with extremely high seed removal at lower distribution edges and low rates of seed removal beyond the tree line. At the micro-environmental scale, canopy cover increased seed removal and seed predator abundances, as canopy cover may represent shelter for rodents and thus, protection from potential predators. In contrast, increasing dwarf-shrub cover decreased seed removal, presumably by reducing the detectability of seeds. Our study corroborates the importance of local environmental conditions affecting the interactions between seed-removing animals and plants. Incorporating environmental gradients is critical for a mechanistic understanding of plant regeneration processes across distributional ranges.

END OF SESSION 9

Session 10 - Interactions among individuals

CHAIRS: UTA BERGER, VOLKER GRIMM

O1 - How to model interactions? Towards a standardized construction kit

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Individual-based models (IBMs) represent the emergence of population- and higher-level phenomena from the interactions among individuals and of individuals with their abiotic environment. Since individual-based modelling is now beyond its infancy, generic and re-usable approaches have been developed that can serve as building blocks in a general modelling construction kit. I will present results from a review of IBMs that have been described using the standard format „ODD“, which includes „interaction“ as a key design concept. I will show that there is in fact only a small number of powerful ways to model interactions which can be used for a broad range of questions and systems. This and further standardized building blocks for IBMs will allow to develop predictive models of not only populations but also of communities and ecosystems.

O2 - How do calcareous grassland cryptogams affect the germination of vascular plant seeds?

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Calcareous grasslands are among the most species-rich ecosystems worldwide. Most of the vascular plants of calcareous grasslands can only germinate in microsites with favorable light conditions. Light availability at the soil level is high enough to form a dense cryptogam layer that can inhibit seed germination.

In a series of greenhouse experiments, we test (I) which cryptogam and seed traits determine the fate of vascular plant seeds in calcareous grasslands. We also want to differentiate between (II) the barrier function of cryptogams which block the seeds from reaching the soil and (III) the reduced light quality below the cryptogam layer.

(I) Seeds of 36 vascular plant species were sown into plots covered by nine different cryptogam species. Results showed reduced germination under cryptogam mats, depending on cryptogam species and seed traits. High moss mats showed strong inhibition, especially for small seeded plant species.

(II) In order to test for the barrier function of cryptogam mats and cushions, we dropped seeds from 20 vascular plant species in mats of five characteristic cryptogam species from their natural shedding height. Most seeds were not able to

reach the soil but remained in the cryptogam layer. Seed penetration depth was correlated with terminal velocity of the seed and negatively correlated with the presence of seed appendices.

(III) To test for the effect of light interception by the cryptogam layer we placed the seeds of 5 vascular plant species below mats of 6 cryptogam species. One part of the cryptogam mats were treated with a bleaching agent to remove all organic compounds affecting light transmission. Light spectra were measured below intact and treated cryptogam mats with a portable spectrometer. The spectra of untreated cryptogams showed a strongly reduced light quality, e.g. in the red/far red ratio, which directly affects germination of seeds. Plots covered by intact cryptogam mats showed lower seed germination rates than plots covered by bleached moss mats.

Strong effects of light absorption and barrier effect could be shown on almost all plant species. The species composition of the cryptogam layer can strongly influence germination of seeds depending on their specific traits, and thereby affect succession pathways of open grasslands.

O3 - Species-specific effects decouple biodiversity and ecosystem functioning in pesticide-exposed communities

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Support for the positive effect of biodiversity (BD) on ecosystem functioning (EF) comes mainly from the experiments where communities were assembled by random species selection. However, whether this relationship holds in communities shaped by non-random environmental filtering is unknown. Here, we analysed data from ecotoxicological community-level experiments to assess how BD, EF, and the stability of both in fresh-water communities are shaped by application of the pesticide chlorpyrifos. To this end we applied the method described recently in Gross et al (2014, *EcolAppl*), which enabled us to measure the relative effect of the treatment on mean and variation of both BD and EF. The pesticide affected the mean and variation of 11 out of 13 indices measuring the biodiversity of macroinvertebrate community and 3 out of 13 indices measuring the biodiversity of zooplankton community. Evenness was affected more compared to the species richness; and macroinvertebrate biodiversity was affected more in the recovery phase compared to the phase following the pesticide application. However, none of the three tested EFs (gross production, dissolved oxygen and respiration) or their

stability were affected. Consequently, none of the EFs changed along the pesticide-induced BD gradient. Species-specific contributions to EF may explain the decoupling of BD and EF in pesticide-exposed communities. We found that the relationships between the abundance of each single species and EF depended on species identity, ranging from positive over neutral to negative relationships. We encourage further use of the method suggested by Gross et al. (2014, *EcolAppl*) for disentangling the effects of treatment on mean and variation of the variable of interest (BD or EF). We call for further studies assessing B-EF relationships in more realistic settings, formed by non-random community assembly, as provided by ecotoxicological experiments.

O4 - Effect of competition history and herbivory on the competitive interaction between *Tanacetum vulgare* and *Solidago canadensis*

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Worldwide, invasive species have developed into pests being a threat to native biodiversity. Goldenrod (*Solidago canadensis*) is an invasive plant that was introduced to Europe from North America and has now become a serious pest occurring in the habitats of the native tansy (*Tanacetum vulgare*). While in many places this two plant species are coexisting there are worries that tansy might be replaced over time. To test the potential of tansy being replaced by goldenrod, we investigate the competitive interactions between both species in a greenhouse experiment as depending on the competition history (mother plant of tansy growing in the vicinity of goldenrod) and experimental herbivory by *Spodoptera* sp. (no herbivory, symmetric herbivory on both plants or asymmetric herbivory on only one plant). In the experiment, goldenrod suffered more in competition with tansy compared to competition with goldenrod. In contrast, tansy performance was reduced stronger by competition with tansy compared to goldenrod. In contrast to goldenrod, there was an effect of competition history on tansy performance. Tansy performance increased much stronger for plants in competition with goldenrod when plants had a competition history. Generally, there were only weak effects of herbivory reducing the performance of plants that caterpillars fed on. Even the strongly asymmetric herbivory imposed in our experiment did not change the outcome of competitive interactions between the two plant species. Overall, our experiment showed no competitive exclusion or strongly reduced tansy performance in presence of goldenrod not even when experimental herbivory was strongly favoring goldenrod. On the contrary, tansy competing with goldenrod performed better than tansy competing with another tansy. This effect was especially strong for tansy plants with a history of competition with goldenrod. Consequently, our greenhouse experiment does not indicate a danger of tansy to

be replaced by goldenrod in Europe. If such a replacement is occurring it would have to be caused by other mechanisms like maybe extreme climatic events.

O5 - Trait-mediated indirect effects of spiders on plants

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The classic 'green world hypothesis' predicts strong impacts of predators on plants by killing herbivores. In addition, trait-mediated effects of predators on the prey (e.g. changes in feeding behaviour) can affect plants as well. To test for trait-mediated effects, we exposed arthropods to predator chemical cues in the lab and in the field.

In the lab experiment, crickets were able to choose between a control plant and a plant bearing either spider or ant cues. We quantified plant choice, weight gain of the crickets and herbivory during the experimental period. In the field experiment, we repeatedly enclosed spiders on plants. After three days of cue deposition arthropods were allowed to colonise and feed on the experimental plants. We quantified herbivory and sampled the arthropod community on the plants.

Crickets avoided plants bearing spider cues. Consequently, herbivory was reduced on plants bearing spider cues. Total herbivory (herbivory on the control and the 'spider plant'), however, did not differ from the double control (two control plants). In the field, spider cues led to complex changes of the arthropod community, namely an increased recruitment of workers of the most frequent ant species *Myrmica rubra*. Herbivory was significantly reduced on plants bearing spider cues.

Our results suggest far-reaching effects of spider predation risk on arthropod communities. In contrast to density-mediated effects (i.e. if predators kill their prey), trait-mediated effects did not reduce net herbivory. Instead, they increased spatial heterogeneity of herbivory. The way predator effects cascade down (density-mediated *versus* trait-mediated) thus determines energy transfer from the basal to the top trophic level.

O6 - Allometric response of mangroves to resource availability - a new mechanistic modelling approach

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Recent efforts in the development of individual based mangrove stand models focus increasingly on responses of the trees to competing neighbours and environmental conditions. To acquire this, a mechanistic understanding of individual biomass allocation is essential since the allocation into above- and below-ground parts determine both competition mode and strength of neighbouring plants. The recently introduced tree model BETTINA is focussing on that issue. Within BETTINA, light and water are considered as the main resources being processed in a fixed proportion. Growth is taking place to improve the uptake of the prevailing limiting resource. With a mechanistic conception of water uptake due to pressure gradients between leaf and soil matrix the water availability is directly depending on salinity, i.e. osmotic potential of the soil water. This allows an attribution of allometric measures to water transport properties of the plant parts. Thereby, it opens the way to explain individual growth, i.e. enhancement of allometric measures, depending on individual resource availability. These measures are not limited to predefined maximum measures, but result of and depend on the environmental conditions. Although we present the model for the single tree, BETTINA provides a physiological explanation of plastic responses to resource limitation by competition or abiotic stress. Thus, it has a great potential for an improvement of the understanding of the individual adaptation of plants to their specific environmental conditions. Incorporated in forest simulators, it is capable to improve the forecast of forest dynamics considering tree-level mechanisms. Further, it opens the way for a quantification of below ground resource use and with this a feedback of the individual on the site conditions. We discuss the potential and limitation of this mechanistic approach for future individual-based forest modelling.

O7 - Inter-specific competition enables coexistence of plant species

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By using simulation experiments with mesoFON, an individual-based model of forest dynamics, we can boldly go where no man has gone before and address the ultimate question of plant ecology “Why on earth are here so many kinds of plant organisms, why do so many plant species coexist?” in new, previously unknown ways.

We carried out simulation experiments with two plant functional types (PFTs) that have high intra-specific competition due to local propagule dispersability: one has the capability of lateral crown displacement (PFT_plastic), while the other is lacking this ability (PFT_rigid).

Irrespective of the initial sapling numbers PFT_plastic finally out-competes PFT_rigid in all experiments. This stood in stark contrast to the stable equilibrium prediction of a traditional Lotka-Volterra model applied to carrying capacities and intra-/inter-specific competition coefficients measured during model runs. A redefined Lotka-Volterra model is able to resemble the observed behavior. In this model, local dispersal merely speeds up or slows down competitive exclusion despite the strong intra-specific competition it provokes.

However, by applying a simple experimental method to boost inter-specific competition, we find a stable equilibrium and coexistence in the virtual reality. In this model, excessive reproduction and fitness represent the amplifier which is problematic for coexistence, whereas strong inter-specific competition is not the problem, but the solution for species coexistence.

O8 - Interplay of spatial pattern and competition asymmetry shapes size correlations between neighbouring plants

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Both positive and negative correlations between sizes of neighbouring individuals within plant populations have been observed many times. Negative correlations have been interpreted as a result of competitive asymmetry, i.e. the advantage of big individuals over smaller ones in competition for resources. Positive correlations, in turn, have been usually considered a result of site heterogeneity, genetic relatedness or facilitation, although they may also result from symmetric competition when the spatial distribution of individuals is not uniform.

Using individual-based spatial competition models we show how irregularity of spatial distribution and competition asymmetry may jointly shape correlations between neighbour sizes. While competition asymmetry promotes negative correlation, irregularity of spatial pattern promotes a positive one. As a result, positive correlations may arise even under moderately asymmetric competition, but negative correlations seem to appear only as a result of competition asymmetry. By statistically controlling for the areas available to individuals when

computing size correlation between neighbours one may be able to assess the mode of competition.

We simulated very large populations, but we also consider possible application of our findings to guide the assessment of competition asymmetry in real-world data by analysing plots of moderate size drawn from our simulation results. Since the variability of sample correlations is very high, only large samples can serve as a basis for reliable interpretations.

We compare our simulation results with data from a glasshouse experiment on an annual plant. Due to the small sample sizes the results are not fully conclusive, but they do not contradict findings from large-scale simulations and are intuitively consistent with them.

P1 - Plants as ecosystem engineers - The impact of plant morphology on local water distribution

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Plants are sessile organisms and as such depend on sufficient local water supply. At the same time, plants themselves directly influence the spatial water distribution in the soil. Thus, plants partly regulate their own water supply. Current ecohydrological models apply simplified approaches to assess infiltration and the spatial distribution of water. They especially neglect different morphological traits of the vegetation leading to spatial heterogeneity in soil water. For example, the shape of the leafage and the rooting system strongly impact the amount of water that reaches the soil and how it is spatially distributed.

If rainfall hits the leafage only a fraction of the water falls through directly. The remaining fraction is intercepted and firstly accumulates on the leaves. This water either runs down the stem (stem flow) or evaporates directly. As a result, more water is received in the local environment of the stem than under the remaining canopy. The rooting system additionally influences the amount of infiltrated water and its distribution in the soil: Roots lead to preferential flow paths and form small caverns that increase the water storage capacity.

In our work we explicitly address the influence of different morphological plant traits on the spatial water distribution in the soil. For this we developed a simulation model to track the path of rainfall from its first contact with the leafage to its storage in the soil. Our model structure supports simulations for different morphological plant types that allow us to evaluate the effect of branch structure, leaf density and the rooting system on water fluxes and thus local availability. The parameterization of morphological traits is based on 2-D profiles derived by simple image processing of pictures. This provides a highly flexible framework to evaluate

different scenarios, which we aim to couple with a dynamic vegetation model in the future.

P2 - Exploring variation in predation rates by individual-based modelling and laboratory experiments

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I combined detailed laboratory measurements of predator-prey interactions in *Notonecta* backswimmers feeding on *Daphnia* with a mechanistic individual-based model to explore variation in predation rates. Experimental data showed that *Notonecta* feeds on *Daphnia* according to a type II functional response. Predation rates were, however, strongly affected by starvation level and interference between predator individuals. In addition, large individual-level variation in predation rates was detected. I developed a mechanistic individual-based model describing the movement and interactions of predators and prey, parameterized it by detailed behavioural data recorded using a video camera and compared observed and predicted prey mortality. This approach allowed to quantify the role of stochasticity in individual movement for observed variation of predation rates. The individual-based foraging model is based on established theoretical concepts (models of movement, density-dependent foraging and energetics) and aims to provide a building block for a new class of general individual-based food web models, currently under development.

P3 - Facilitation stabilizes species coexistence by favoring rare species

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Facilitation is increasingly recognized as a potential driver of diversity: positive interactions among plants can relax environmental filters and allow more species to establish in a given site. However, the role of facilitation to ensure coexistence among species has been seldom addressed. For species to coexist, negative frequency-dependent mechanisms are required, meaning that species populations must be able to increase when species become rare. Such negative frequency-dependent (*stabilizing*) mechanisms include herbivory on the most dominant species or niche segregation that results in higher intra- than inter-specific competition. We hypothesized that facilitation can also benefit rare species more than common ones. Two mechanisms lie behind this hypothesized effect i) nurse plants create "safe sites" for rare species to escape competition, and ii) nurse plant

increase reproductive output of their neighbours, which disproportionately benefits rare species. To test the role of facilitation as coexistence mechanism, we used a large database of own and published studies with over 1200 pairwise interactions between plant species estimated in more than 200 sites worldwide. We show that facilitation was stronger for the rarest than the common species, regardless of habitat-type, species identity, the prevailing environmental conditions or the facilitation metric used. Our results clearly support the role of facilitation as a mechanism that can increase the population size of the rarest species, thus potentially ensuring coexistence. We provide further mechanistic understanding of the role of facilitation in the maintenance of plant diversity by highlighting a previously ignored mechanism while providing a link between facilitation-diversity relationships and modern coexistence theory.

P4 - Effect of belowground herbivory on aboveground herbivory, pollination and fruit production in the bittersweet nightshade (*Solanum dulcamara*)

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Belowground herbivory can influence subsequent interactions with aboveground herbivores and mutualists through altered plant defence chemistry, nutrient composition or resource allocation, but the temporal dynamics of these effects are not well understood. We examined aboveground herbivory, flowering time, pollination and cumulative fruit production in the native bittersweet nightshade (*Solanum dulcamara*, Solanaceae) after previous or during continuous belowground herbivory by *Agriotes* spp. larvae (Elateridae, Coleoptera). Data from two experiments conducted at different sites are presented. The results are discussed with respect to the question whether previous transient belowground herbivory causes sufficiently strong effects to alter defence and reproduction in *S. dulcamara*.

P5 - Alarm pheromone emission of *Aphis fabae* when attacked by different predators

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Within a group, organisms use different ways of communicating. Chemical communication through alarm pheromones is common among many species of aphids. When a predator attacks they secrete the volatile alarm pheromone (E)- β -farnesene (EBF) in droplets from the siphunculi, tube-shape structures located on

the dorsal side of the aphid body. The alarm call has defensive significance to warn other colony members about the presence of the predator. When an aphid perceives the alarm pheromone behavioral changes can occur, e.g. dropping from the plant and moving away. Although the alarm signaling is well known there are still some aspects, such as the effect of predator identity, which still need further study. We used black bean aphids (*Aphis fabae*) to investigate the variability of alarm pheromone emission when attacked by different predators (lacewing and ladybird larvae). We used a zNose™ gas chromatograph, allowing real-time volatile analysis of EBF emission in the laboratory. We found that not all aphids emitted EBF when attacked by a predator even though every aphid contained EBF. This was also partly influenced by the predator identity with more aphids emitting EBF when attacked by lacewing larvae than by ladybird larvae. These differences may be partly explained by the difference in feeding behavior of these two predators. Alarm pheromone emission can influence aphid population distribution among host-plants since the aphids often disperse when EBF is perceived. Since predator identity can influence EBF emission, we suggest that the composition of the predator community can also influence aphid dispersal and distribution among host-plants.

P6 - Indirect interactions between native and alien plant species driven by phylogenetic distance and plant traits

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Alien plants usually suppress native plant species in an introduced community. In light of Darwin's naturalization hypothesis (DNH), presence of natives that are phylogenetically closely related to aliens is more likely to directly restrain the latter (due to potential niche overlap), and thereby indirectly alleviate or release the suppression, while this might not occur in the case of the presence of phylogenetically far related natives. However, this postulated pattern might be logically perplexed if interactions between species are more driven by competitive ability rather than by phylogenetic similarity. To unravel this complexity and thereby test the DNH in a tri-species competing system, we chose ten groups of quadr-species (a common / a rare alien, native related, native non-related and focal native species) and grew them in monoculture, pair-wise and triple combinations. We measured growth and survival, as well as functional traits of plants which might account for the interaction consequences. We found that the focal species were significantly suppressed by the aliens, while the suppression merely occurred aboveground, not belowground. The suppression was not indirectly released by the presence of phylogenetically closely related natives, also not of phylogenetically far related natives. This might be because the aliens appeared not to be more suppressed by the former than by the latter in both pair-wise and triple species systems. In summary, this implies that the interaction consequences might be in

effect driven by competitive ability (and its potential representatives, functional traits) other than phylogenetic distance. However, this needs to be evidenced by further analyses of the data.

END OF SESSION 10

Session 11 - Aboveground-belowground interactions in novel soils

CHAIR: NICO EISENHAUER

O1 - Effects of leaf litter diversity on the decomposition of plant polyphenols

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Plant polyphenols are important secondary metabolites in leaves and are thought to play a key function in different ecological processes (e.g. as defense against herbivory and microbial attack or in modifying soil processes). However, there are only a few comparative cross-species studies to test these ideas. In particular, little is known about the fate of phenolic compounds in the course of leaf litter decomposition. We asked how leaf litter decomposition of different species is related to total polyphenol content. Additionally, we tested how mixtures of litter from different species varying in total content of phenolics affect litter decomposition. We hypothesized that the decomposition rate of leaf litter increases with a decrease of phenolics contents due to microbial degradation and that more diverse litter positively affects the decomposition rate of polyphenols.

We made use of a litter decomposition experiment in the context of the BEF-China project (www.bef-china.de), in which leaf litter of nine Chinese tree species was sampled at five time steps from one species or from a mixture of two to four species in different combinations. Total phenolics were determined using the Prussian Blue Assay. Tannin content was assessed using a modified version of the Radial Diffusion Assay. In addition, HPLC-MS/MS was employed to tentatively identify specific polyphenol compounds.

We encountered a decrease in total phenolics and tannin content, which however is strongly depended on other leaf traits (such as leaf dry matter content) and plant species identity. We showed that the decomposition rate of polyphenols is positively influenced by litter diversity and is up to a magnitude higher than overall leaf decomposition rates. More than 50 different compounds were detected by HPLC analyses of which 28 could be tentatively identified. In addition, decomposition affected different weight classes of polyphenols similarly, resulting in an even reduction of all types of compounds.

The results of our study provide a better functional understanding of the role of polyphenols in litter decomposition. However, it is an open question why decomposition of polyphenols is faster than of total leaf dry matter, a finding which challenges the idea that polyphenols preserve organic matter from microbial decomposition.

O2 - Negative interactions between macro-decomposers affect litter decomposition in a functional tree diversity gradient

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Litter decomposition is one of the most important ecosystem processes, but the interactions between different groups of decomposers still remain largely unknown. We set up a microcosm experiment consisting of four different decomposer treatments (control, with earthworms, with isopods, with both decomposer groups), along a functional leaf litter diversity gradient with 24 different litter compositions (based on the design of the BIOTREE site in Bechstedt), to look at interactive effects of decomposers on litter decomposition.

Earthworms reduced the weight gain as well as population growth of isopods, and isopods decreased the weight gain of *L. terrestris*. No additive effects of the two groups on litter decomposition were found; the decomposition rate was mostly dependent on the presence of *L. terrestris*.

The functional diversity of the litter material showed no significant effect on litter decomposition, but we found significant identity effects of some tree species. Functional litter diversity significantly decreased isopod performance in the treatment with earthworms. The decomposer treatments had significant interactive effects on the decomposition of most litter species, with the exception of beech, oak, and pine litter.

Analysis of basal respiration and soil microbial biomass decreased significantly in the presence of earthworms. However, no significant effects of functional litter diversity and isopods on soil microbial properties were found. This study shows that leaf litter decomposition can be significantly determined by negative interactions between different groups of decomposers, with effects being mostly dependent on litter identity, but not functional diversity.

O3 - Extracellular microbial enzyme activity in decaying wood in a natural forest diversity gradient

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Coarse woody debris (CWD) plays an important role in forest ecosystems. Dead wood stores up to 22% of the forest carbon, is relevant for nitrogen and phosphorus recycling and is also a source of biodiversity and nutrients. The main decomposers of CWD are saproxylic insects and a wide array of wood decaying fungi. The latter use extracellular enzymes to mediate the decomposition of wood components, which are related to wood mass loss rates. Wood species traits may also be important for the decomposition dynamics. For instance, conifer logs decompose slower than broad-leaved species. More generally, gymnosperm wood has significantly higher lignin content whereas wood of angiosperm has higher nitrogen and phosphorus concentration and also a higher wood density. Most of what is currently known about the wood decomposition enzymes is derived from studies in temperate and boreal forests, and only from lignin and cellulose degradation enzymes. Subtropical forests remain poorly known. To test the dynamics of coarse woody debris in subtropical forests we conducted an experiment in 27 permanent study plots in South-East China as a part of the BEF-China experiment. We measured decay rates as well as microbial enzyme activities of six enzymes: acid phosphomonoesterase, leucine aminopeptidase β -1,4-N-acetyl-glucosaminidase, β -1,4-glucosidase, phenol oxidase and peroxidase. Decay rates and enzyme activity were determined for *Pinus massoniana* (Pinaceae; a gymnosperm) and *Schima superba* (Theaceae; an evergreen). To evaluate the influence of macro invertebrates for decomposition and enzyme activity we integrated an insect exclusion through the use of litterbags. We found that there was no difference in enzyme activity between the control and insect exclusion. Furthermore, the enzyme activity of β -1,4-N-acetyl-glucosaminidase, β -1,4-glucosidase, phenol oxidase and peroxidase is higher in the angiosperm *S. superba*. Also, we confirmed that mass loss is directly related to lignocellulase activity. Our results help to understand wood decomposition dynamics in the early growth of subtropical forests and indicate that the production of extracellular enzymes seems independent of the presence of macro invertebrates.

O4 - Functional linkage between soil fauna activity and mycotoxin degradation in straw cover

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Mesocosm-field studies were conducted to assess the interaction between belowground soilfauna and the mycotoxin deoxynivalenol (DON). The objective was to demonstrate that DON concentration in wheat straw at the soil surface decrease substantially in the presence of soilfauna. In 2011 and 2013, mesocosms were established in the topsoil of a winter wheat field located in Northern Germany. Soilfauna in different combinations (earthworms (E), E + collembolans (C), E + nematodes (N), E + C + N and a non-faunal treatment) was exposed to artificially *Fusarium culmorum*-infected wheat straw highly contaminated with DON (2011: 318.56mg kg⁻¹; 2013: 40.97 mg kg⁻¹). Wheat straw with a low concentration level of DON (<2.54 mg kg⁻¹) served as control. After an experimental time span of 4 and 8 weeks, the DON concentration in residual straw and in soil was determined by using a competitive ELISA test kit. In both experimental years the initial DON concentration decreased in all treatments after 4 weeks, whereas the highest reduction was determined throughout the faunal treatments (2011: 97-99%, 2013: 78-90%). The reduction of initial DON concentration in the non-faunal control treatments was significant lower (2011: 87%, 2013: 68%). After 8 weeks a further decline of DON concentrations was measured in all treatments containing soil fauna (2011: 46-88%, 2013: 67-85%), whereas the highest reduction was found in mixed treatments due to faunal interaction. DON contents in residual straw increased in the non-faunal treatments during the final four weeks in both experimental years. In contrast, the concentration of DON in soil of the mesocosms was below quantification limits (<0.037 mg kg⁻¹) throughout all treatments in 2011 and 2013, respectively. Our results clearly demonstrate that earthworms, collembolans and nematodes contribute in an interactive manner to a sustainable control of *Fusarium*-related contaminants in wheat straw thus reducing the risk of plant diseases and environmental pollution as an important ecosystem service for soil health.

O5 - Litter breakdown in different land-use systems in Mato Grosso, Brazil

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Litter decomposition is one of the most important processes occurring in soil ecosystems. It influences nutrient cycling, carbon accumulation, and CO₂ emissions.

Since it is regulated by physical, chemical, and biological processes, it can be affected by land-use change.

Due to diverse drivers, the state of Mato Grosso, Brazil has experienced significant land cover changes in the last 40 years. Native forests have been converted to pastures and subsequently to farmland. This agricultural expansion started in South Mato Grosso, moved towards North, and is encroaching into the state of Pará.

On this basis, we studied the factors influencing litter decomposition in dominant land-use systems in Mato Grosso, i.e. soybean/maize field, pasture, and native forest, in two regions along a south-north geographical gradient. Litter breakdown was measured through the litterbag technique, using the original litter (soybean, *Brachiaria*-grass, forest litter) in every land-use system and maize as a standard substrate for comparison between sites. The experiment was carried out during the dry and rainy seasons, separately. Additionally, two different mesh sizes were used to compare the effect of soil fauna with microorganisms.

First results in the southern region showed that season > litter quality > land-use are the most significant factors influencing the breakdown process. Land-use had a greater impact on decomposition during the dry season. Soil fauna accelerated up to 50% the breakdown process. The analysed parameters explain approximately 80% of the variation in the observed litter mass losses.

O6 - The establishment of terrestrial food webs in tropical rice soils after conversion to non-flooded crops

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Trophic interactions are key elements of ecological functioning. While well established food webs are regularly explored, very little quantitative information is available on their establishment and assembling, leaving fundamental questions in the temporal dynamics of food webs unexplored.

We assessed soil food webs in conventional rice fields at the International Rice Research Institute (IRRI), Philippines, and analyzed the impact of conversion from predominantly flooded systems to rotations with non-flooded crops. In the dry season 2013, nematodes and mesofauna were extracted from 36 plots representing i) flooded rice after flooded rice, ii) aerobic rice after flooded rice, iii) maize after flooded rice, iv) maize after aerobic rice. The food web was modeled following De Vries et al. (2013), statistical analyses were done by the GLM approach.

Soil food webs were rudimentary in the conventional continuous flooded rice cropping system. The introduction of alternative non-flooded cropping systems triggered the structuring and development of a terrestrial soil food web. Under dry crop management soil respiration was initially higher implying a more diverse and

functional soil food web. Generally predators consumed a much higher ratio of prey than in established food webs of agricultural soils.

We conclude that regular flooding prevents the gradual development of a soil food web as well as its functional ripening. Our model metrics show that alternative cropping systems result in either short-term (rotations with flooded rice) or long-term (continuously dry crop rotation) overexploitation of food resources. This is amplified by the fact that the extraordinarily high predation pressure on primary consumers further decreases the stability of the fragile soil community at its early stage of development. The dominance of the carnivorous channel is most probably largely due to asynchronous colonization, since soil predators tend to be much more mobile than their microphyto- and saprophagous prey. As a consequence, even the dry crop rotation is still in a very premature stage.

O7 - Effects of future rainfall patterns on soil microarthropods in typical agricultural soils of the Pannonian region

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Regional climate change scenarios for the end of this century predict fewer but heavier rainfalls and longer lasting droughts during the vegetation period, especially in summer and autumn, for Eastern Austria (Pannonian region). In a multidisciplinary study, the impact of altered rainfall patterns on agro-ecosystems was investigated at the AGES Lysimeter station, which comprises the three main soil types (calcaric phaeozem, gleyic phaeozem, and calcic chernozem) of the Marchfeld region, together covering about 80% of the agricultural area. Precipitation rates were modified according to the predicted scenario for 2071-2100 in comparison to the current precipitation patterns averaging the amount and frequency of precipitation between the years 1971 and 2000. The abundance, diversity and species composition of selected soil microarthropod groups (Collembola, Gamasida, and Oribatida) were monitored for three years.

Considering the microarthropods, the soils under investigation proved to be well buffered with respect to short term precipitation changes. Although several, partly significant effects were observed with respect to the factors soil type, season and irrigation treatment, there was no overall clear trend for one of these parameters. A high degree of uncertainty concerning the impact of climate change on soil fauna arose from large yearly variation, seasonal effects and different reactions of the microarthropod groups. Collembola were solely affected by soil type whereas

Gamasida and Oribatida were significantly affected by all factors investigated. The irrigation treatment had no significant effect on all microarthropod groups across all three years but significantly affected Gamasida and Oribatida in single years. For all three groups a significant irrigation treatment x soil type interaction was observed. In general, the largest proportion of overall variation with respect to abundance, species richness and composition was attributed to soil type.

O8 - Trophic niches and utilisation of food resources in collembolans based on complementary analyses of fatty acids and stable isotopes

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Feeding on a variety of resources, collembolans have been assumed to be food generalists. However, recent stable isotope analyses documented that collembolan species occupy different trophic levels, but detailed studies on species-specific food resources are sparse. Fatty acid (FA) and stable isotope analysis allow insight into utilisation of basal resources and trophic levels of consumers, respectively. We combined these methods to investigate variations in trophic niches of six collembolan species (*Lepidocyrtus lanuginosus*, *Folsomia quadrioculata*, *Parisotoma notabilis*, *Ceratophysella denticulata*, *Isotomiella minor* and *Protaphorura armata*) in beech and spruce forests. We correlated collembolan FAs with that of litter microorganisms at the respective study sites to identify links to resources. FA composition and stable isotope signatures in collembolan species did not differ significantly between forest types but between species suggesting pronounced trophic niche differentiation between species. *C. denticulata* and *P. armata* were similar and significantly differed from that of each of the other species with ¹³C and ¹⁵N signatures being least depleted. We suggest at least *C. denticulata* to live as predator presumably feeding on nematodes. Due to intermediate to low ¹³C and ¹⁵N levels and specific FA compositions the other collembolan species could be ascribed to secondary decomposers with *I. minor* being more closely associated with bacterial resources and *F. quadrioculata*, *L. lanuginosus* and *P. notabilis* with fungal resources. However, dietary niches presumably comprise a mixture of resources rather than single resources. FAs in collembolan species correlated poorly with those in litter suggesting that the diet of collembolan species is rather independent of the structure of microbial communities in bulk litter. The results suggest that collembolans consume resources of microsites rather than bulk material thereby benefitting from the small-scale heterogeneity in resource distribution in soil. Low variation in trophic niches with forest type suggests that these microsites are similar across different forests and provide similar food resources despite marked differences in e.g., litter materials and humus structure.

P1 - Dispersal ability of Collembola changes under different types of land-use

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The aim of our study was to explore the colonization potential of springtails (Collembola) in grassland soils from geographically distant regions which are subject to different land use types and to compare colonization rate of collembolans into defaunated soil and in soil inhabited by a native collembolan community. We conducted a two months-long outdoor microcosm experiment in which we combined pair-wise intact soil blocks (5 cm wide, 10 cm long and 10 cm deep) from the three DFG Biodiversity Exploratories regions: Schorfheide-Chorin, Hainich-Dün and Schwäbische Alb subject to the two land use types: meadows and mown pastures (n=3 for both land use types). In one half of the microcosm battery one block in each microcosm was defaunated and in the other half of the battery both blocks contained indigenous collembolan community. Control microcosms for each grassland site with an indigenous collembolan community were also established. In total 138 microcosms were established. Colonization rate of defaunated soil from mown pastures was nearly significantly lower than in the meadow soil (9 vs 29 ind. respectively on average) (ANOVA, $F=4.03$, $p<0.06$). The average relative normalized migration balance between different soils with the natural collembolan communities (sum of the collembolan abundance change in two soil blocks relative to the collembolan abundance in respective controls) of mown pastures was 2.3 per microcosm and 0.5 of meadows (ANOVA, $F=4.69$, $p<0.05$). This means that in the meadows immigration prevails over emigration on average but individual migration is lower than in the mown pastures. This is probably explained by the lower abundance of euedaphic collembolans in the mown pasture compared to meadow soil (3.6 and 12.6 ind. per microcosm respectively on average) (ANOVA, $F=6.23$, $p<0.02$). The results suggest that in more compacted soils of mown pastures colonization of new substrates is more active due to the higher density of surface-dwelling springtails.

P2 - The effect of metal pollution and over-fertilization on cellulose decomposition

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Decomposition is crucial for nutrient cycling within ecosystems. The process can be easily disturbed by extensive human activities leading for example to metal pollution and over-fertilization. In soils polluted with metals, the rate of decomposition decreases. Studies with elevated nitrogen input provide

contradictive results. On the one hand, in terrestrial ecosystems nitrogen is a limiting factor so its addition improves ecosystem performance. On the other hand, it is known that high concentrations of nitrogen compounds suppress the synthesis of some enzymes, which affects decomposition limit values and slows down the process.

This research focuses on the effects of elevated N on cellulose decomposition in pine forest stands along a metal pollution gradient.

A transect with six study sites has been established near Miasteczko Śląskie, Poland, where soil contamination ranges between 155-2906 mg Zn·kg⁻¹, 173-5580 mg Pb·kg⁻¹ and 2-52 mg Cd·kg⁻¹. At each site three NH₄NO₃-fertilized and three non-fertilized plots were created. Cellulose filter discs were placed at the plots in June 2013 and subsequently, between June and December six samplings were performed. Every time three bags from each plot were taken (18 per site, 9 per treatment) and mass loss was determined.

At the end of the experiment, the greatest mass loss was noted at the least polluted site, where only approx. 16% of initial mass remained. At the most polluted site decomposition was lowest, with 37% of initial mass left after the exposure period. We also observed that excessive nitrogen tends to negatively affect cellulose decomposition rate, however the extent of that seem to be related with Mn concentration.

P3 - Land use intensity and plant diversity drive earthworm communities throughout riparian areas in southern Québec

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Understanding the land use and land cover factors that drive the spatial patterns of earthworm communities is of key importance in southern Quebec, given that the spatial organization of non-native earthworms can significantly influence soil functions – particularly in riparian areas. Few studies have explored earthworm populations in temperate North American riparian environments, even though earthworm presence in these soils may accelerate nutrient transfers between terrestrial and aquatic ecosystems or may increase N₂O emissions. The objective of this study was to determine how agricultural land use, vegetation patterns in forest patches, and soil parameters influenced earthworm populations and communities. We selected three study sites along the Pike River in southern Québec. At each site, there were four transects representative of varying land use and proximity to the river. In each transect, earthworm populations and soil properties were evaluated in five plots, four separate times from fall 2009 to spring 2011. Additionally, vegetation cover and diversity were studied, and land owner surveys were done to

evaluate land use intensity. Earthworm abundance and diversity was highest in a riparian forest transect (460 individuals m⁻², and 9 species) and riparian agricultural buffer (325 individuals m⁻² and 10 species); abundance and diversity was lowest in the upland agricultural fields with annual crop rotations and synthetic inputs. RDA analysis revealed that land use intensity, soil moisture, vegetation diversity, soil nitrogen and phosphorous explained the variation in earthworm community composition throughout the three sites. The larger, more diverse earthworm communities in forests and agricultural riparian buffers make a greater contribution to decomposition and nutrient cycling, but this remains to be determined.

P4 - Functional and structural response of soil microbial communities to additional stressors, does historical pollution matter?

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Previous studies have shown that long-term metal pollution may lead to the selection of more tolerant microbial communities to metal pollution. Such selection may however, also potentially lead to a loss of resilience regarding other stressors. We therefore examined how exposure to four additional stressors (arsenic, NaCl, Benzo(a)pyrene and flooding) affected the functional and structural response of microbial communities from two gradients of long-term metal pollution in Poland. These two transects have previously been characterized, documenting that the long-term exposure to metal contamination not resulting in large shifts in community structure and functional capabilities composition along the gradients, as revealed by high resolution molecular approaches. In this study endpoints were basal respiration rates (BAS) as indicator of “functional stability” and bacterial communities structure determined by denaturing gradient gel electrophoresis (DGGE) as proxy of “structural stability”. BAS and community structure in soils accustomed to higher metal contamination levels seemed more resistant to arsenic and NaCl stress compared with communities in less polluted soils. In contrast, relative change in BAS and community structure in both heavily polluted and less polluted soils were equally resistant to Benzo(a)pyrene and flooding stress. Our results suggest that long-term metal exposure plays a role in determining the functional and structural response of microbial communities to additional stressors, but also that it depends on the type of stress factors whether this will lead to severe additional effects.

P5 - Earthworm communities in grasslands of different cutting frequency and fertilization intensity

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Cutting frequency and the intensity of fertilizer application are the two main management factors in cultivated grassland in Central Europe. Earthworms are known to be affected by the amount and quality of plant residues in such systems. Hence, the number of seasonal cuttings in combination with fertilizer amounts is hypothesised to have direct and indirect effects on the size and structure of the earthworm communities. In a field experiment, we investigated the earthworm community response to different cutting frequencies and fertilization intensities. Two fertilizer treatments were established: (1) no fertilizer and (2) 180 kg ha⁻¹ a⁻¹ nitrogen, 30 kg ha⁻¹ a⁻¹ phosphorous and 100 kg ha⁻¹ a⁻¹ potassium. Within both fertilizer treatments, two cutting treatments were carried out: (1) only 1 cut per season and (2) 3 cuts per season. The resulting 4 treatment combinations were repeated 6 times in the field (24 plots). Earthworms were extracted from the soil using a mustard extraction method in May 2013 (3 extraction replicates on each of the 24 plots). In total, 5 different species (*Lumbricus castaneus*, *Lumbricus rubellus*, *Lumbricus terrestris*, *Aporrectodea caliginosa*, *Aporrectodea rosea*) were found covering all 3 ecological groups. *A. caliginosa* and *L. terrestris* were most abundant. Highest number of individuals was detected for the “no fertilizer/1 cut” treatment (180 ind. m⁻²; average for all plots 161 ind. m⁻²). Lowest biomass was recorded for the “fertilizer/1 cut” treatment (40 g m⁻²; average for all plots 50 g m⁻²). Significant effects were only found for the epigeic species, having lower numbers and biomass in the “no fertilizer/3 cut” treatment compared to the other treatments. Earthworms as a whole make use of both above and below ground plant litter but feeding preferences on the species level still remain unclear in most cases. This needs to be investigated in more detail to fully understand above-below ground interactions in complex grassland systems.

P6 - Dynamic of microorganisms during litter decomposition in Cerrado soils under different land use systems in Campo Verde, Mato Grosso, Brazil

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The state of Mato Grosso, particularly the southern region, began in the 1980's to adopt agricultural conservation practices, such as no-tillage. In this practice, straw is used as soil cover in order to minimize the loss of soil productive potential and reduce the elevated production costs, besides improving physical, chemical, and microbiological soil properties.

The study aim to assess the temporal dynamic of microorganism populations during maize litter decomposition in three land use systems: 1) soybean field (in rotation with maize), 2) native *Cerrado* forest, and 3) pasture in the region of Campo Verde, Mato Grosso, Brazil.

Maize litter was placed in litterbags and exposed 20 weeks during the rainy season 2012/2013. After each collection (n=4) bacteria, actinomycetes, fungi, cellulolytic and phosphate-solubilizing microbes were quantified. Microorganism populations varied depending on collection periods. The highest number of microorganisms was found in litter placed in the pasture, followed by the soybean field, and finally the *Cerrado*. Fungi and actinomycetes were predominant in the beginning of the experiment, while bacteria dominated towards the end.

END OF SESSION 11

Session 12 - Plant acclimation and adaptations

CHAIRS: TAMIR KLEIN, YANN VITASSE, GÜNTER HOCH

O1 - Signatures of selection in climate-related traits of Norway spruce (*Picea abies*) and silver fir (*Abies alba*)

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The question how and whether tree species are able to adapt to rapidly changing climatic conditions is crucial from an ecological as well as economical point of view. Thus far, the velocity of genetic adaptation in long living trees species are largely unknown. Next generation sequencing techniques and constantly growing genetic resources in tree species enable researchers to identify and investigate variability in candidate genes. In parallel, intensive phenotyping is of utmost importance in order to identify critical traits that are under selective pressure under climate change. For many plant species it has been shown that phenology, especially bud burst and bud set dates are likely to shift under a warmer climate. In addition, annual increments derived from wood cores allow assessing individual variation in the reaction towards climatic extremes in the past. In our study, we focused on two conifer species, Norway spruce and silver fir. Trees are sampled in plots at low and high elevations in the Bavarian Forest National Park, Germany. Under the assumption, that selection is particularly strong in early life stages we included adult trees as well as saplings in our study. We expect to find differences in allele frequencies in climate related candidate genes between cohorts as well as along the environmental gradient. We genotyped Norway spruce and silver fir at 1536 and 240 SNPs respectively, many of them located in candidate genes related to phenology or drought stress. In both species, bud burst was monitored in spring 2014 and wood cores were analyzed for annual increments. In order to screen the data sets for signatures of local adaptation we used analytical approaches based on allele frequencies and environmental factors (i.e. Bayenv, LFMM) correlated genotype and phenotype data. Currently, data analysis and phenotyping is under way and results will be presented during the conference.

O2 - How freezing resistance shapes the range limit of beech

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Low temperature is one of the most important factors driving species distribution at the global scale. Temperate trees have evolved to optimise their physiology and phenology against the risk of freezing damage during any time of the year. Here we

aimed at finding the acclimation and deacclimation potential of freezing resistance in beech trees during winter and spring, and the subsequent risk for beech to encounter lethal freezing temperature to key tissues. We investigated the genetic and phenotypic component for the acclimation of freezing resistance in buds of adult beech trees from three different populations along a natural temperature gradient in the Swiss Jura Mountains to cold temperatures in mid winter. Further, we studied the acclimation and deacclimation potential of freezing resistance to cold and warm temperature in one of the populations during spring. We show that freezing resistance of beech correlates with temperature of the site of origin in mid winter, ranging from -25 °C to -40 °C according to the climate of origin. However, beech exhibited a remarkable potential for acclimation to cold temperatures in winter. After artificially hardening samples at -6 °C for 5 days and at -15 °C for an additional 3 days, samples of all provenances were freezing resistant to -40 °C independent of their origin, suggesting that freezing resistance in beech is highly plastic, while the genetic differentiation among populations is small. While the acclimation potential is large in winter, it decreases during spring and the potential for deacclimation increases. Consequently, beech encounters the highest risk of freezing damage during flushing in spring, when they are very active and the probability of a freezing event is still high. To escape freezing damage, beech delays flushing along elevation at the cost of a shorter growing season at higher elevation. We conclude that beech is generally safe from freezing temperature in winter, due to the large acclimation potential. We suggest that freezing resistance, the associated timing of spring phenology, and the resulting length of the growing season jointly reflect species-specific life history requirements that control tree species cold range limits.

O3 - Relative effects of temperature vs. photoperiod on growth and cold acclimation of northern and southern *Arrhenatherum elatius* ecotypes.

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Growth of perennial grasses in the fall represents a balance between an extended growing season and increased vulnerability to frost. Within species along latitudinal gradients, plants may exhibit ecotype-specific sensitivities to the temperature and photoperiod cues that influence cold acclimation. Therefore, it is unclear for a given latitude how climate warming will alter the timing and extent of cold acclimation, and thus vulnerability to frost events. We evaluated relative temperature and photoperiod sensitivities during simulated cold acclimation for two northern (Swedish) and two southern (Italian) ecotypes of the common forage grass *Arrhenatherum elatius*. Three temperature levels (Temp_{low}: 3 °C, Temp_{high+low}: 8 °C followed by 3 °C, and Temp_{high}: 8 °C) were crossed with 2 photoperiod levels (Photo_{short}: 6 h, and Photo_{long}: 12 h) and administered to the plants for a three week

acclimation period. All plants were then frozen at $-8\text{ }^{\circ}\text{C}$ for 1 d, and post-frost growth was measured after 3 weeks. $\text{Temp}_{\text{high}}$ and $\text{Photo}_{\text{long}}$ increased growth prior to frost, but resulted in decreased growth after frost. The effects of temperature on sugar concentration, biomass and flower presence depended on photoperiod, with temperature only influencing sugar concentration and flowering at $\text{Photo}_{\text{short}}$ while $\text{Photo}_{\text{long}}$ increased biomass only at the high temperature. The faster growth rate of southern *A. elatius* ecotypes before frost, in combination with sufficient cold acclimation, resulted in higher biomass accumulation after frost. The faster growth habit of southern ecotypes may be advantageous in accumulating higher summer biomass even after moderate frost events in the fall.

O4 - Plastic responses to warming and drought in plant functional traits of alpine and lowland plants

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Alpine regions are frequently considered as being at risk from warming temperatures and drought. In this context, common gardens are ideal to study the effects of global warming as they allow transplantation of plants from their original elevations down to elevations with a prospective climate.

For this purpose, we transplanted 14 alpine herbaceous species to two sites along a mountain slope (1000 and 2000 m.a.s.l.) and examined whether plant functional traits adjusted plastically to elevation and watering regimes. This design was replicated with congeneric lowland species to assess if the degree of phenotypic plasticity differs between lowland and alpine species. After one growing season, biomass and SLA were measured. During the second growing season survival and root:shoot ratio were assessed to compare the performance of species in each environment. Additionally, a phenotypic plasticity index was computed for the plant functional traits to analyze the degree of phenotypic plasticity of lowland and alpine species.

The study species showed different responses to treatments but overall biomass (after the first growing season) was higher for lowland species in all treatments and generally decreased significantly with elevation and drought. Similarly, SLA decreased with elevation and drought, as an adjustment to temperature and radiation. Survival was independent of treatments and origin of species and a total of 76% of the initially planted individuals underwent a second growing season. Over all treatments, the root:shoot ratio was consistently higher in alpine species and was more constant at high elevation, indicating a higher constraint on biomass allocation at high elevation. Even though the responses of alpine and lowland species to warming and drought differed for some of the functional traits, none of them showed significant differences in their degree of phenotypic plasticity.

These results indicate that the high selective pressures of the alpine environment do not necessarily constrain phenotypic plasticity. Furthermore, the alpine species showed a remarkable capacity for survival in a prospective climate as they rapidly adjusted their traits to environmental conditions and even seemed to benefit from higher temperatures at lower elevations.

O5 - The snow and the willows: Accelerated spring snowmelt reduces performance in the alpine shrub *Salix herbacea*

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Current changes in shrub abundance in alpine and arctic tundra ecosystems are primarily driven by warming, and changes in snow cover and growing season length. However, as warming and earlier snowmelt are not necessarily correlated, we need to understand the effects of both factors on tundra plants to predict future vegetation changes. To disentangle the response of different traits to earlier snowmelt and warmer temperatures along an elevation gradient, we investigated 480 patches of *Salix herbacea*, a widespread alpine and Arctic dwarf shrub, along its elevational and snowmelt microhabitat range over three years in a space-for-time substitution.

Earlier snowmelt was associated with longer development time for all phenophases, increased likelihood of herbivory and fungal damage, fewer stems and no increase in fall wood carbohydrates. While early snowmelt was associated with an increased proportion of flowering stems, the number of fruiting stems was not, as fruit set decreased with earlier snowmelt. Warmer temperatures at lower elevations were associated with decreases in stem number and wood low-molecular weight sugars, and increases in stems fruiting.

We conclude that most measured traits of *S. herbacea* are influenced by snowmelt, which mainly reduced performance in *S. herbacea*. The most likely mechanisms driving many observed patterns are adverse conditions in the early growing season. Increased likelihood of leaf damage during early snowmelt could lead to long-term reductions in performance. Longer phenological development time under early snowmelt could increase exposure to leaf damage during vulnerable early development stages. Reduced fruit set under early snowmelt lowers overall shrub fitness. We conclude that early snowmelt represents an important mechanism reducing dwarf shrub performance as a result of climate change. Future predictions

of shrub performance in tundra ecosystems should carefully consider both changes in snowmelt and in temperatures.

O6 - Phenotypic plasticity of the alpine dwarf shrub *Salix herbacea* in response to earlier snowmelt: lessons from a multi-site transplant experiment

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Climate change is altering snowmelt patterns in alpine and arctic ecosystems. The timing of snowmelt can alter plant phenology, growth and consequently fitness. In order to predict how the long-lived dwarf shrub *Salix herbacea* will respond to shifts in snowmelt timing, we reciprocally transplanted clonal fragments of *S. herbacea* between early-exposure and late-exposure microhabitats. We monitored phenological, morphological and fitness traits as well as leaf damage, during two growing seasons to determine the effect of snowmelt change on each set of traits.

Phenological development and leaf size of *S. herbacea* was found to strongly depend on snowmelt timing, with longer development time and smaller leaves in early- relative to late exposure sites. Phenological development time did not influence fitness, but smaller leaves in early exposure sites resulted in reduced sexual reproduction. Plants originating from early- relative to late exposure sites had a lower vegetative reproduction and this difference increased during the experiment. We found no home-site advantage in terms of sexual- and vegetative reproduction. The likelihood of leaf damage was greater on early- relative to late exposure sites.

We conclude that *S. herbacea* can respond to shifts in snowmelt timing by plastic changes in phenology and leaf size. Plants from late-exposure sites might be able to better tolerate environmental changes in the short term, due to higher vegetative growth and thus resource storage capacity. Generally, an advance in snowmelt might be more detrimental for *S. herbacea* relative to a lag, due to an increased exposure to damage by herbivores and pathogens.

O7 - Are leaf morphology traits and phenology reliable indicators of acclimation to a new environment?

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One of the main responses of temperate deciduous trees to climate change, besides migration, will be in-situ adaptation. Therefore, phenology together with leaf morphological traits may be relevant for the study of phenotypic plasticity (acclimation) and consequently inherent capacities of plants to adapt to an ever changing climate. Especially in alpine regions. The aim of this study was to evaluate the changes in possible adaptive traits (e.g. leaf morphology and phenology) of beech (*Fagus sylvatica* L.). We collected beech seeds at six sites along two transects at a south (900, 1000 and 1100-1400 m a.s.l.) and a north facing slope (800, 900 and 1100 m a.s.l.) in 2011 near Garmisch-Partenkirchen, Germany. Seeds (150) from each site were sown in a common garden (508 m a.s.l.), phenology of every seed was recorded three times a week. Harvesting took place 38/42 days after sowing, specific leaf area (SLA), biomass, and leaf morphology were recorded for each seedling. To compare differences in leaf morphological traits we also collected seedlings grown under natural conditions at the same sites and measured leaf traits. In the common garden seeds from lower sites of the two transects presented clearly poorer germination rates when compared to seeds originating from respective higher elevations. No significant differences in SLA were found among the altitudinal levels in any of the transects. A higher percentage of germinated seeds originating from higher altitudinal sites may point to a developed sensitivity to environmental changes and a rapid and more favorable response. Various plasticity indices calculated pointed out that seedlings growing under natural conditions have a higher degree of plasticity in SLA than those growing in a common garden. Our results suggest that the altitude of origin does not have an overriding impact on leaf morphological responses when growing in a common garden.

O8 - Scaling and coordination of xylem hydraulic traits worldwide

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The ability of the xylem to supply water to the transpiring leaf surface at the rate set by evaporative demand fundamentally determines plant growth and survival across environmental gradients. Here we present a data synthesis examining the functional diversity of xylem traits using a database of 1078 plant species. The

database encompasses root and shoot level traits for angiosperms, gymnosperms and ferns across a broad range of biomes and phylogenetic affinities. This analysis addresses (a) how key xylem functional traits determining water stress tolerance and hydraulic efficiency are related to major environmental variables, (b) the relationships between functional traits and xylem structure, (c) co-ordination of xylem traits and branch level sufficiency of water transport to the leaves, and (d) relationships between hydraulic and biomechanical traits.

O9 - Quantifying acclimatisation, qualifying adaptation - differences detected

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Provenances of one tree species are the result of adaptation to the local environment by natural selection. Therefore genetically different, a comparison of provenances planted at one location disclose the differences between them. Additionally we use the climate-growth relationships to visualise the process of acclimatisation to a changing environment.

Using standard dendrochronological methods we sampled six Norway spruce (*Picea abies* [L.] Karst) provenances planted in Saxonia /Germany at two contrasting sites. Applying the program CLIMTREG climate-growth patterns were detected on the basis of daily meteorological data. This enables us to estimate future growth till 2050 and compare the resistance and adaptive potential to a changing climate.

Results show clear differences between the provenances with, however, the influence of the local site conditions dominating the overall growth pattern. Climate-growth correlations show patterns changing over time, with acclimatisation becoming clear over the years; thus decreasing the impact of the climate scenarios on growth. While the use of an early calibration period projects a growth decline after 2012, a growth increase is apparent for most provenances using a later calibration period.

Differences between the modelled growth up to the year 2055 allows a quantification of the effect of acclimatisation as well as a rough estimate of the time needed for a tree to do so. Nevertheless, with extremely unfavourable site conditions acclimatisation plays a minimal role. Comparing the response to extreme climatic events (e.g drought year 2003) of the different provenances a relative homogenous pictures underlines the importance of site condition over the genetic differences.

O10 - Drought resistance within and between *Pistacia atlantica* populations: Implications for dryland afforestation in the era of climate change.

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The increase in drought frequencies in the era of climate change requires special considerations in open areas management in general and afforestations specifically. The aim the study was to understand the distribution of drought resistance properties, among and within the natural populations of *Pistacia atlantica* along the rainfall gradient in Israel, in order to integrate the native species in afforestation that would withstand future climate uncertainties. The main questions of the study were: 1. Can the species establish and develop in drought-prone environments? 2. If it can, are drought resistance-related traits found only in specific populations, or in all populations of the species along the rainfall gradient? In a set of field and greenhouse experiments, including a wilting experiment, we have found that populations of *Pistacia atlantica* as well as the genotypes within the populations, indeed differ in their drought tolerance, and that some drought tolerance properties can distinguish between the populations of *P. atlantica* along the rainfall gradient in Israel. The offspring from the genotypes of the southern populations showed significantly higher drought resistance and late wilting comparing to the center and northern populations. We discuss implications for dryland afforestation.

O11 - Identifying adapted provenances of Douglas-fir for future

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Climate change poses serious challenges to sustainable management of forests throughout the world. Planting of alternative and also non-native tree species or different provenances better adapted or having a higher potential for adaptation to future climate conditions has been discussed as an important silvicultural measure to adapt forests to climate change. Douglas-fir (*Pseudotsuga menziesii* var. (Mirb.) Franco) is considered as one of the most promising species in Austria and elsewhere, because it exhibits superior productivity, high wood quality and low

risks for storm damage. The aim of the study is to identify suitable provenances of Douglas-fir with Universal response function (URF) that predicts growth potential as a function of climate variable of both trial location and provenance origin. Mean height of dominant trees (75 percentile of tree height of each provenance) was used as an indicator of growth potential. We utilized growth data from 60 trials throughout Austria and Bavaria in Germany to develop the URFs that predicts height at age 24 as a function of climate variable of both trial location and provenance origin. Multivariate analyses were used to identify the important climate variables to be used to develop the URFs.

We found that Mean annual Temperature of both trial location and provenance origin explains major amount of variation in height growth potential of the provenances. We also found that coastal provenances outperform the interior provenances in most part of our study area.

P1 - Statistically modeling the influence of climatic factors on bud burst timing in silver fir and Norway spruce

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Climate predictions for Europe show an increase in warmer winters, late spring frost events and lower precipitation rates for the coming decades. Challenged with these factors temperate forest tree species are expected to alter their timing of phenological stages such as bud burst dates in spring.

Bud burst is said to be triggered by the depth of winter chilling and the accumulated heat sums in spring. For it is not yet known which of them is the most important and whether precipitation rates or photoperiod also show an influence on the timing, our study focuses on the correlation of different climatic factors with bud burst in saplings and adult trees of two European coniferous tree species.

In spring 2014 we monitored bud burst timing of *Abies alba* MILL. and *Picea abies* (L.) KARST. in the Bavarian Forest National Park. The plots each include ~150 saplings and ~100 adult trees at two different altitudes set at ~750m and ~1100m a.s.l. for silver fir, respectively at ~700m and ~1300m for Norway spruce. Available weather data from data loggers located within the plots was used to calibrate recordings from regional weather stations. This data gave us the opportunity to correlate different factors including photoperiod, temperature, precipitation, air humidity and cloud cover with the monitored bud burst timing.

In a first step we applied a model which calculated the Growing Degree Days above a certain threshold temperature needed for the buds to burst. This will show us

whether bud burst of trees at different altitudes and in different life stages is triggered by different heat sums and could provide first insights on whether trees show local adaptation in their phenology. In a second step we aim to incorporate additional climatic factors to test whether this increases the predictive power of the model. First results of our study will be presented to discuss whether temperate forest tree species already show signs of local adaptation to a warming climate.

P2 - Evaluating the adaptive potential of bud burst in silver fir (*Abies alba*) under climate change

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Bud burst is an important phenological trait in trees, marking the initiation of the vegetative period. It is known to be controlled by various environmental factors including temperature sums, winter chilling and photoperiod. Bud burst timing further seems to be under strong genetic control, making it an ideal trait to investigate the adaptive potential of forest trees to changing temperature regimes as predicted under climate change. Silver fir (*Abies alba* Mill.) is an important species in silviculture and natural habitats, providing an ecologically and economically relevant model to address the question of bud burst control on both a temperature and a genetic level.

For this purpose the timing of bud burst was recorded during springtime in 2014 in the Bavarian Forest National Park at ~770 m and ~1120 m a.s.l. representing a difference in mean annual temperature of about 2.1°C. At both elevations, sampling plots comprise 100 adult trees and about 150 saplings representing two cohorts that established under different climatic conditions. For all trees, 232 SNPs were genotyped that are mostly located in candidate genes related to drought stress. In order to detect loci that are associated with differences in bud burst timing, genotype data will be correlated with phenotype data using mixed-effects linear models and a Bayesian mixed-effect association approach. Changes in allele frequencies between elevations are indicative for local adaptation in these candidate genes while changes between cohorts provide information on ongoing adaptation to changing temperature regimes.

The results of this study will enhance our understanding of the evolutionary and adaptive relevance of bud burst in the context of climate change.

P3 - Signatures of selection in *Abies alba* along an environmental gradient

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Forest ecosystems are increasingly influenced by global change. Trees as their keystone elements provide a multitude of ecosystem functions. Changing phenological phases due to climate change could fundamentally alter the structure and composition of forests in many regions. European silver fir (*Abies alba* Mill.) is an important forest tree species that covers a large geographic range of central and southern Europe. More research is needed to understand how trees might adapt to such climate-induced changes. In order to investigate whether there are signatures of selection - and thus potential adaptation - in *A. alba* we genotyped a total of 500 individuals from the Bavarian National Park at 242 SNPs that are mostly located in candidate genes. Sampling plots were located at ~ 1100 m a.s.l. and ~ 760 m a.s.l. with 100 adult individuals and 150 saplings in each plot. Bayesian approaches were used to investigate potential population substructure. In order to infer loci under selection based on their allelic frequencies we employed *Bayescan* and *Lositan*. Such outlier approaches can effectively identify genes under selection without knowledge of phenotypes. In addition, we applied environmental association methods that detect loci under selection by correlating environmental variables, which were used as proxies for ecological pressure, with allele frequencies. By taking advantage of more information than genome-only-based methods these approaches are more powerful. Software packages such as *Bayenv* and *LFMM* account for population structure (e.g. the effect of population history) which limits the number of false-positives and false-negatives. Genes that contained outlier loci were subsequently studied in more detail and their potential function for adaptive processes were analyzed. First results are presented and discussed.

P4 - Growth responses of maritime and continental provenances of boreal plants to warming winters

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The responses of six boreal plant species were studied in a reciprocal overwintering experiment. Two provenances (continental and maritime) of each species (*Deschampsia flexuosa*, *Festuca ovina*, *Fragaria vesca*, *Hypericum perforatum*, *Pinus sylvestris* and *Vaccinium vitis-idaea*) were grown in pots in an experimental garden

in Helsinki, Finland. The pots were transferred to two overwintering sites at the end of October 2013. In inland southern Finland winters are cold and snow cover is permanent (continental site), whereas mild winters and ephemeral snow cover prevail on the Åland Islands (maritime site). The climatic gradient between the two sites simulates the expected changes in winter climate in southern Finland due to global warming.

The effects of winter climate on the state of dormancy were studied by transferring plants from the two sites to growth chambers (+10°C) to test ability to resume growth in different phases of dormancy. Differences between the provenances were generally small, but major differences were observed between the two overwintering sites. Plants that overwintered at the continental site were exposed to low temperatures towards the end of the year, which may have accelerated release from endodormancy. As a result, plants that overwintered at the continental site resumed their growth faster than plants that overwintered at the maritime site in early winter (December).

The opposite pattern was observed in mid-winter (February) when endodormancy release was probably completed at both sites. Plants that overwintered at the maritime site resumed growth faster than the ones that overwintered at the continental site. This suggests that the ontogenetic development of plants towards growth onset proceeds faster under the mild winter climate of the maritime site.

In conclusion, the winter climate had a major effect on the state of dormancy. How changes in dormancy affect spring phenology, growth and reproduction will be studied in a further experiment.

P5 - Snow conditions affect recruitment and the subsequent growth of *Allium oleraceum* bulbils

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The effects of snow cover on the recruitment and growth of bulbils of *Allium oleraceum* were studied in a snow manipulation experiment. Bulbils were collected from six populations of *Allium* along a maritime-continental gradient in southern Finland. The populations represented both tetraploid and pentaploid cytotypes. The bulbils were planted in 15 plastic growing trays that consisted of 5x6 conical cells. The trays were placed on 1m² plots where snow cover was manipulated during the following winter. Two types of manipulations were carried out: (1) snow was repeatedly removed to 10 cm, and (2) snow was repeatedly added to increase its thickness by 15 cm compared with natural snow cover (control). The timing of growth onset was observed in the autumn, the length growth of leaves was measured during winter, and the bulbs were weighed at the end of the following growing season.

In all populations the majority of bulbils (57% - 99%) started growing in the autumn, and bulbils that originated from continental populations started growing earlier than those that originated from more maritime populations. More than 95% of all bulbils started growing by the beginning of the following growing season, and no snow manipulation effect was observed. Significant leaf growth was observed under snow. On control plots the average leaf length increased by 114% in tetraploid populations, and by 254% in pentaploid populations during the winter. The length growth was 40% smaller both on the snow removal plots, where low freezing temperatures were measured, and on the snow addition plots, where low availability of light may have limited growth. The changes in snow cover had long-lasting effects on the growth of bulbs. Compared with natural snow cover, snow removal decreased the weight of 1-year-old bulbs by 20% and snow addition by 10% at the end of the growing season. Comparable growth responses can be expected if the thickness and duration of snow cover changes due to global warming.

P6 - Flowering phenology in alpine and lowland plants in response to warming and drought

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Timing of flowering phenology is crucial for alpine species because of the short growing season at high altitude. In the context of climate change, our study aimed at elucidating the effects of warming and drought on the reproductive phenology of alpine species when transplanted down to sites with a prospective climate and at comparing their responses with those of lowland species.

13 alpine herbaceous species were transplanted to two sites along a mountain slope (1000 and 2000 m.a.s.l). Reproductive phenology was monitored weekly during the growing season to examine if the timing and duration of bud-break, flowering and fruiting changed in response to elevation and watering regimes. This design was replicated with congeneric lowland species to assess if the degree of phenotypic plasticity between alpine and lowland species differed in response to warming and drought.

Changes in reproductive phenology in response to transplantation were species specific but all phenological stages were initiated earlier at the lower site. At both sites, alpine species initiated reproduction earlier than lowland species and drought advanced the respective stages at low elevation but had fewer effects at high elevation. Midpoint of flowering, crucial for successful pollination, was recorded earlier at the lower site, especially for alpine species. Environmental conditions at the lower site prolonged the duration of phenological stages for most species while drought often shortened it. In conclusion, alpine and lowland species adjusted their

reproductive phenology remarkably to environmental conditions and seem to have a very similar degree of phenotypic plasticity regarding their phenology.

P7 - UV-B radiation and drought - Combined stress effects on native and exotic origins of *Verbascum thapsus* L.

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While studying individual effects of global change has largely been under consideration and provided evidence of shifts in plant species performance and species communities to date, more recent research ambitions have identified the importance of testing for the role of interacting components of global change. Apart from resident plant communities also plant invasions have to face new environmental challenges and are influenced by aspects of global changes, including more stressful environmental conditions e.g. in temperature, precipitation and UV-B radiation. In this context, we investigated an invasive plant species of New Zealand (NZ) grasslands, which in its invaded range is being exposed to two concomitant, limiting abiotic factors – high levels of ultraviolet-B radiation (UV-B) and drought. To evaluate the extent as to which *Verbascum thapsus* may respond via plastic and/or adaptive responses, we assessed the effects of these two interacting stress factors in a greenhouse experiment comprising native German and exotic NZ origins of the species. Individuals of nine to ten native and exotic populations were grown within four treatments resulting from the crossed combinations of two levels ('with' and 'without') of UV-B and drought, respectively. Over twelve weeks, we recorded growth, morphological characteristics and physiological responses. Every three weeks a subset of individuals from all populations was harvested to determine productivity of the plants depending on origin, drought stress and UV-B over time. The results showed that drought stress had the strongest effect on the plants, i.e. reductions in biomass and changes of morphology were observed regardless of origin. This limiting effect of drought was never increased by high UV-B levels, but plants have shown to respond more sensitively to effects of UV-B when being well-watered. Our findings hint at comparable physiological responses in plants which can be similarly evoked by any of the two investigated environmental stress factors. We conclude that drought resistant plant species might be predisposed to deal with high UV-B levels and, thus, possess a valuable advantage during invasions in such exposed habitats.

P8 - Influence of photoperiod sensitivity among and within tree species on breaking bud dormancy.

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Photoperiod sensitivity plays a major role, in combination with chilling day requirements, in determining bud dormancy of trees and subsequently their growth responses to global warming. We compared among and within-species photoperiod sensitivity by testing individual tree dormancy levels along a temporal gradient at two photoperiods. Potted two year old tree seedlings of 8 species and 8 ecotypes of *Fagus sylvatica* were buried to pot edges in a sand bed and overwintered 2013 -2014 in Bayreuth, Germany. From mid-December to mid-April 2 replicates from every species and ecotype were transferred every 7-10 days into climate chambers at 20°C; one replicate at 16 hour photoperiod and another at 8 hour photoperiod. Days required for tree seedlings to burst bud were recorded. A total of 14 sets of plants per species and ecotype were incubated to bud burst to generate "sampling date vs. number of days to bud burst" regressions. Ratios of the long photoperiod slopes to short photoperiod slopes were considered as a proxy for light sensitivity in relation to budburst. Light sensitivity varied both among and within-species. *F. sylvatica* was the most photoperiod-sensitive while *Picea abies* was the least photoperiod-sensitive. Generally, northern ecotypes of *F. sylvatica* were more photoperiod-sensitive than the southern ecotypes. *Quercus robur*, *Picea abies* and *Tilia cordata* had non-linear sample date vs. days to bud-burst relationships. Across all species and ecotypes greater light sensitivity was positively correlated with steeper long photoperiod slopes. Taken together, the results indicate that common European tree species as well as their ecotypes differ in their overall dormancy patterns as well as photoperiod sensitivity, the latter potentially playing as large a role as the chilling day requirement in determining the ease of breaking winter dormancy. Less photoperiod sensitive species and ecotypes may be able to take advantage of future projected mid-winter warm spells and earlier spring with earlier growth onset, provided they withstand the sudden frost events which will continue to occur.

P9 - Rainfall manipulation and productivity along an aridity gradient in Mediterranean natural ecosystems.

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In regions with Mediterranean type of climate, water is a main factor driving the functioning of the ecosystem. Effects of rainfall manipulations on primary biomass production (productivity) of herbaceous vegetation were tested in a field experiment, along an aridity gradient in Mediterranean natural ecosystems. This long-term study (10ys) deals with:

1. Productivity responses to rainfall manipulations *in situ*, along the aridity gradient.
2. Effects of inter-annual variation in rainfall on productivity across the gradient.

END OF SESSION 12

Session 13 - Functional plant ecology

CHAIRS: MAAIKE BADER, ARTHUR GEBLER

O1 - Tree carbon allocation dynamics using a carbon mass balance approach

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The dynamics of carbon (C) allocation in trees are fundamental to their functioning as well as to forest C stocks, with major implications on the terrestrial C cycle. A full description of tree C allocation dynamics must account for all C fluxes and pools in a tree. These include compartment- and compound-specific C pools and the internal C fluxes between them, which are difficult to measure directly. On an annual time-scale, healthy trees maintain a C mass balance between source (assimilation) and sinks (respiration, growth, export to soil, and litter). However on shorter time-scales, storage (starch synthesis) and cash (starch degradation) can buffer source-sink imbalances, and hence must be included in the analysis.

In this study we collected independent measurements of all tree C inflows, outflows and pools (both at the compartment and compound level) from *Pinus halepensis* in a semi-arid forest, into a dataset where all fluxes were converted to g C tree⁻¹ d⁻¹. Using this dataset, a simple flow model was created to describe and quantify the long- and short-term tree C balances.

The annual C source of 24.5 kg C tree⁻¹ year⁻¹ was balanced by C sinks of 23.5 kg C tree⁻¹ year⁻¹, which, in turn, partitioned into 70%, 17%, and 13% between respiration, growth, and litter (plus export to soil), respectively. On the monthly time-scale, large imbalances (up to 57 g C tree⁻¹ d⁻¹) were observed as C excess during the rain season, and as C deficit during the dry season. Our model showed that concurrent changes in C reserves (starch) were sufficient to buffer these transient C imbalances.

The C pool dynamics simulated in the flow model were in good agreement with the observed pool sizes. This provides confidence to our estimations of the timing, magnitude, and direction of the intrinsic transport fluxes simulated by the model. These intrinsic fluxes indicated small (6 g C tree⁻¹ d⁻¹), yet persistent, relocation flows from roots to the stem, and from the stem to the leaves, during July-August.

O2 - Carbon reserve pool size has no effect on the survival time of broad-leaved tree saplings exposed to late season drought

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It is generally assumed that the size of the carbon (C) reserve pool of a plant is indicative of its net C-balance. In contrast, it has been recently hypothesized that the frequently observed initial increase of non-structural C reserves (i.e. starch and lipids) in trees exposed to drought, is not caused by an overabundance of photoassimilates following the cessation of growth, but might be an intrinsic reaction to anticipate potential C-limitation under stressful situations. Because sustained drought might lead to C starvation in trees that are able to avoid hydraulic failure, high initial C reserve pools are assumed to be beneficial for trees to survive longer under drought.

Within two experiments with saplings of two broad-leaved tree species (*Carpinus betulus*, *Quercus petraea*) we tested the responsiveness of non-structural carbohydrate (NSC) pools to C-shortage and -surplus, and assessed the significance of the size of C-reserve stores to survive drought stress. In order to manipulate the NSC pools, the seedlings were either grown in one of three shading treatments (no shade, 90% shade, 95% shade), or exposed to one of three CO₂ treatments (600, 400, 200 ppm CO₂) during the first half of the growing season. In both species, NSC concentrations showed significant declines between April and June at low light and low CO₂ concentrations, corroborating the indicative nature of NSC for a tree's C-balance. However, during the second half of the season (July to October), NSC concentrations increased significantly also under severe C-limitation, indicating a strong genetic control over reserve formation, even against prevailing C-limitation. Half of the saplings from each shading and CO₂ treatment were additionally subjected to drought stress from July until the seedlings' death in October. Surprisingly, there was no difference in the drought survival time among the different shading and CO₂ treatments. Drought led to a moderate decrease of NSC concentrations in roots and stems of both species within the CO₂ experiment and in *Carpinus* within the shading treatment, while it tended to increase NSC concentrations in *Quercus* within the shading experiment. Hence, we conclude that drought survival was independent of the initial C reserve pool size in both studied tree species.

O3 - Gaps, bridges and scales: ecophysiological research from processes to organisms and beyond

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Ecophysiological research aims at bridging gaps between ecology and physiology by investigating physiological processes at scales that allow upscaling to the organismic and ecosystem level. In this talk I will give an overview of ecophysiological studies we are carrying out at the Department of Biogeochemical Processes of the Max-Planck Institute for Biogeochemistry in Jena. We explore key processes and organisms that regulate exchanges of energy, water and elements

between ecosystems and their surroundings, and how those processes are affected by climate variation and land management. While initially focusing on tree physiological responses to drought, my research in the department now spans across plant functional types and includes processes such as symbiotic interactions between plants and microorganisms. I will provide an overview of our research questions and the experimental designs we address them with. I will show the main results we obtained in the recent past but also introduce new projects and investigations that have been designed in response to those results. This rather lecture-style presentation is intended mainly as a primer for discussion but also as a catalyst for scientific collaborations.

O4 - From the leaves to the stem - transport of isotopic signals in adult forest trees

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The carbon and oxygen isotopic signatures of assimilated carbohydrates keep record of the ecophysiological conditions under which they were formed. Extracts of water-soluble organic matter from leaves have been shown to represent the fast turnover fraction and can be related to water-use efficiency, stomatal conductance and the rate of photosynthesis of the preceding hours or days. However, in the process of phloem loading and transport to the stem, the signals may be altered. Therefore, the quality of ecophysiological information that is retained during the travel to the stem phloem is under current debate. Knowledge of these relationships is also a prerequisite for the use of tree ring cellulose for ecological studies.

In our study, we followed the isotopic signals of water-soluble organic matter from the foliage of three different canopy heights across twig and branch phloem down to the stem phloem. The sampling was repeated seasonally in European beech and Douglas-fir growing in pure and mixed stands. Simultaneously, transpiration has been measured by xylem sap flow on the branch and on the whole tree level. Photosynthetic parameters have been determined seasonally via porometry using a controlled chamber. The microclimatic conditions have been surveyed along the crown gradients.

In the water-soluble organic matter, the oxygen isotope enrichment was strongly dampened from the leaf to the twig phloem. The dampening was most pronounced in Douglas-fir and in the shaded crown layers of beech. In the upper beech crown, phloem organic matter kept most of the leaf signal in July and August. In comparison, the further alterations of the oxygen isotopic signatures on the way down to the stem phloem were inferior. However, while the depletion of ¹⁸O with decreasing height was mostly continuous in Douglas-fir, the lowest D¹⁸O values (28.9 ± 1.5‰) in beech were found at the crown base rather than at breast height.

Our results give evidence, that, in the two investigated species, the oxygen isotopic signature of stem phloem organic matter is partly uncoupled from the leaf level.

O5 - Water relations of European tree species are affected by naturally occurring short dry periods

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With climate change, the stochasticity of weather events is predicted to increase. In this context, several studies have investigated the effects of extreme drought events, e.g. the European drought in 2003, on tree physiological processes over the past years. However, little is known how mature European tree species respond to less intense but more frequently re-occurring short-term drought events and heat waves. Here we present data from a study aimed at assessing the species-specific responses in water relations of four common European tree species (*F. sylvatica*, *P. abies*, *A. pseudoplatanus*, *F. excelsior*) to several naturally occurring short dry periods in 2012 and 2013. We conducted our study in a mature mixed mountain forest at Laegeren, Switzerland. To assess the trees' water relations in response to drought events we recorded key climatic data, soil moisture, soil water potential, stem increment using high-precision dendrometers, sap flow and biosphere-atmosphere water and carbon fluxes using an eddy covariance system. Our high-resolution dataset showed for all tree species a clear tree water deficit during all dry periods with *P. abies* being most sensitive. These findings are in accordance with the sap flow data where *F. excelsior*, *F. sylvatica* and *A. pseudoplatanus* showed a less profound decrease in sap flow than *P. abies*. From our study we can conclude that *F. excelsior* is the most drought tolerant species, followed by *F. sylvatica* and *A. pseudoplatanus* whereas *P. abies* responded most sensitive. Our study showed that not only extreme drought events have a significant effect on tree water relations but also naturally occurring short dry periods. With the predicted increase in the number of dry and hot days in the future, such information on species-specific drought responses is essential in order to be able to manage future European forests in a sustainable manner.

O6 - European beech and Norway spruce competing for water - effects of drought on underplanted beech and mature mixed stands

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Underplanting of shade tolerant European beech (*Fagus sylvatica* L.) plays an important role in the ongoing conversion of drought susceptible coniferous monocultures to mixed broadleaf-coniferous forests in Germany. However especially during drought, competition for limited soil water is dominated by the adult trees of the old stand with their high water demand. Results of a three-year throughfall exclusion experiment in a mature Norway spruce stand (*Picea abies* [L.] KARST) previously opened by wind-throw demonstrate the effect of competition by mature spruce on the water available to juvenile beech trees. The study provides novel insights into the concerted light and drought response of beech during the three year establishment phase after planting under the competitive conditions of a mature spruce stand.

Contrasting to such a unidirectional competition situation, recent studies show higher yields of mixed stands of mature beech and spruce when compared with monospecific stands of both species, especially in periods of water limitation. In a current research project, the largely unexplained mechanisms of such over-yielding are to be clarified. The hypothesis is tested that drought limits the water consumption of spruce more severely than that of beech, so that beech under inter-specific competition benefits from water re-partitioning. Therefore, a throughfall exclusion experiment (KROOF) was set up in a mixed stand of mature beech and spruce. Growth as well as relevant physiological parameters are assessed during each of the annual experimental drought periods to investigate underlying drought response strategies of the two species and to clarify the ecological mechanisms of the above mentioned over-yield in productivity.

O7 - Drought as a modifier of interactions between beech and spruce

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The forests of Central Europe were dominated by European Beech (*Fagus sylvatica* L.) and have been changed into Norway Spruce (*Picea abies* (L.) Karst) monocultures in the last 200 years on large areas. Nowadays, the aim is to establish mixed forests of these two species due to their favourable ecological and socio-economic services. In particular under stressful conditions, overyielding was reported in such near-natural mixed-species forests in comparison to mono-specific stands, but the mechanisms of facilitation or competition are only poorly understood. Data is lacking especially to can predict how the mixed systems react

under intensified abiotic stresses (e.g. drought) following prognosed scenarios of climate warming.

The Kranzberg Roof Experiment (KROOF) aims to clarify the mechanisms of intra- and interspecific effects of beech and spruce in response to increasing drought experimentally induced by a throughfall-exclusion experiment in a 70 years - old mixed forest near Freising, Southern Bavaria. The results are compared to the findings from mixed and pure stands of both species along an ecological gradient from moist to dry sites across Bavaria, Germany. First results of the drought stress experiment at the KROOF forest site and the effects on species interactions between beech and spruce are presented. In the focus are the different drought response strategies of beech and spruce (anisohydric vs. isohydric strategy, respectively) under limited water supply. Depending on the strategy it is hypothesized that the different species are suffering primarily from xylem-dysfunction or carbon limitation in consequence of the drought stress.

O8 - Species identity rather than diversity controls spatio-temporal water uptake patterns in subtropical tree sapling communities

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Species-specific water acquisition has rarely been addressed in space and time in experimental tree communities of different diversity. However, such knowledge is essential to understand the importance of diversity for ecosystem functioning based on complementary resource use. We aimed to characterize spatial and temporal water uptake patterns, to assess the role of tree diversity on water uptake patterns and to quantify species niche breadth as well as niche overlap in subtropical tree sapling communities. Our experiment comprised two deciduous (*Castanea henryi*, *Quercus serrata*) and two evergreen tree species (*Elaeocarpus decipiens*, *Schima superba*) planted in monoculture and 4-species mixture. We used deuterated water to trace seasonal water uptake from two soil depths (5 cm and 20 cm). Six days after tracer injection into the soil, stem water was extracted and analyzed for deuterium. Species identity, soil depth and season but not tree diversity had an overall significant effect on δD_{excess} in stem water and proportional water uptake from different treatments. Based on proportional water uptake from different soil layers *Castanea henryi* exploited predominantly the upper soil (74%) whereas *Quercus serrata* (50%), *Elaeocarpus decipiens* (57%) and

Schima superba (62%) tended to use both soil layers more equally. Species also differed slightly in seasonal uptake patterns. Niche overlap between deciduous species was lowest (74%) whereas the two evergreen species had similar water uptake patterns (91%). Although interspecific competition in tree species mixtures did not alter the water uptake pattern of individual species, niche differentiation in water uptake may facilitate species coexistence in young tree sapling communities. Thus, knowledge of multidimensional resource use and niche overlap should be considered in afforestation practices to promote complementary resource use.

O9 - Seasonal effects of drought on the productivity and fodder quality of temperate grassland species

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The effects of drought events on biogeochemistry and fodder production of European grasslands are a highly debated topic. This is because large parts of the land used for agriculture are grasslands. Drought impacts on grassland biogeochemistry and fodder production have been tested in a range of different experiments. Recent work with the attempt to synthesize the outcome of these studies has produced mixed results. A consistent effect of drought on grassland biogeochemistry and fodder production therefore cannot yet easily be deduced from existing studies (Vicca et al. 2012, *New Phytologist*). Largely this is because we lack a common experimental design where different studies vary in the timing and intensity of their drought treatment. In particular the impact of drought events at different times of the growing season is a question that has to date been unresolved and impairs general conclusions on the overall effects of drought on grassland biogeochemistry and fodder production.

To overcome this problem we designed a large-scale field experiment, where we tested the effects of drought events at different times of the growing season (spring drought, summer drought, autumn drought) on the physiological performance and productivity of different grassland species. Specifically, we designed our experiment to disentangle the effects of seasonal drought and the sensitivity of different plant phenological stages by growing monocultures of different grassland species that vary in the timing of their phenology. In my talk I want to present first results of our experiment on the 2014 growing season.

O10 - Patterns of plant functional diversity - ecosystem function relationships at the continental scale

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The range, value and distribution of the functional properties of plants (i.e. the functional diversity, FD) can be assumed to influence ecosystem functioning. However, we are currently not equipped with a consistent set of observations to investigate how functional diversity affects ecosystem functioning at continental scales. In this study we aim at capitalizing on an extensive database of plant functional traits (TRY) in tandem with species distribution data and satellite remote sensing data in order to derive a consistent map of FD across European trees.

We present functional trait maps of 18 foliar and woody traits of trees across Europe, for 168 tree species from four different sources. In order to account for trees growing in plantations, we extend out tree distribution maps by integrating European forestry plot data, climate data from Bioclim and soil data from the European soil database in an ensemble of species distribution models. We construct abundance-weighted functional trait maps by applying a guided hybrid genetic algorithm for feature selection in combination with Random Forests, taking advantage of the vast availability of remotely sensed environmental data as covariates.

In order to emphasize different aspects of FD, including accounting for possible non-linearity of trait correlations and intraspecific trait variability, we apply nine FD indices, correlating them to ecosystem properties. We explore the effects of different traits and species on the overall variability of FD in European Eco-regions and discuss the spatial patterning of different aspects of FD – ecosystem functioning relationships.

O11 - Trait filtering along environmental gradients - community weighted means are better explained than functional dispersion

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The plant functional traits approach has been proposed to verify the concepts of trait filtering, trait-neutral species turnover and limiting similarity. Nevertheless, it

has been hard to test these concepts, as environmental gradients and organism study groups need to be sufficiently large and consistent. Here, we present an analysis of data collected at Mt Kilimanjaro, Tanzania, on a wide range of ecosystems at different elevations, precipitation levels and disturbance regimes. We used climate, soil and disturbance data to understand the influence of the environment on plant functional traits related to different plant life strategies. Overall, we found a strong footprint of trait filtering on the temperature gradient. We expected to find trait-neutral species turnover between distant sites within ecosystems, but this could not be confirmed. Still, a considerable part of the variation in trait community-weighted means (CWMs) and a smaller part of variation in functional dispersion (FDis) could be explained by the abiotic environment. Limiting similarity could not be confirmed to drive trait compositions in naturally growing plant communities. Even the most species-rich associations had functional dispersion values below the expectations of unconstrained null models. We conclude that while trait filtering could be observed to act strongly on the level of individual sites through differences in the abiotic environment, trait-neutral species turnover and limiting similarity could not be detected, the former possibly due to large within-ecosystem differences in abiotic conditions, the latter because of the specific conditions present in the study system.

O12 - Faster-growing herbaceous plant species suffer more negative effects from soil biota than slower-growing species

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The growth-defence trade-off in plants is a major hypothesis in ecology; faster-growing plant species should suffer more from herbivores and pathogens than slower-growing species. However, tests of this hypothesis have been focused aboveground. To test whether faster-growing species suffer more from soil biota than slower-growing species, we independently estimated growth rates of 34 plant species and responses of these species to being grown in soil previously occupied by the species (conspecific) or by a mixture of species (heterospecific). There was a significant negative relationship between the intensity of conspecific soil-biota effects and relative growth rates. Faster-growing species tended to grow less well than slower-growing species on unsterilized compared to sterilized conspecific soils. The exact consequences of this relationship for performance of 'slow' and 'fast' species in a community context deserve further exploration.

O13 - Taking a Deep Breath- Plant Economic Spectrum from a Stomatal Perspective

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Stomata are one of the most fundamental novelties in the evolution of higher plant species enabling them to conquer terrestrial land surface. Their main function is to keep the balance between uptake of CO₂ and water loss. Regulation of gas exchange depends on both, density and aperture and is mediated via changes in turgor pressure of guard cells. Their development is controlled both by gene expression and environmental conditions such as CO₂ concentration, light intensity, nutrient availability and water.

Previous studies have indicated a link in between stomatal parameters and net photosynthesis rates but so far little is known about their correlation to other functional traits related to plant performance such as leaf nitrogen status or specific leaf area (SLA). In order to test whether stomatal parameters namely size and density vary inter- and intraspecifically we conducted research along altitudinal gradients (700- 1800 m a.s.l.) in Garmisch- Partenkirchen measuring functional traits (SLA, leaf N and C content, $\delta^{15}\text{N}$, $\delta^{13}\text{C}$) every 100 m increase in altitude on 22 herbaceous species. To identify important abiotic drivers of the changes we monitored the abiotic environments of the plants as well.

Stomatal parameters vary both inter and intraspecifically along altitudinal gradients. However, contrary to expectations they are correlated negatively to leaf N status and SLA. During the talk the significance of stomatal parameters in functional ecological studies will be discussed.

O14 - Seasonal differences in growth and leaf physiology between lianas and trees. A test of the dry season growth advantage hypothesis.

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Determining the factors that control large-scale patterns of species distributions is a key goal in ecology, yet the mechanisms responsible for the number of lianas and trees through the tropics with annual rainfall have received little attention. Lianas are key components of most tropical forest and they peak in abundance in seasonally dry tropical forests. The dry season growth advantage hypothesis propose that lianas are more abundant in seasonally dry forest because they may avoid physiological stress by remaining active and growing during dry periods. We tested the dry season growth advantage hypothesis for liana and trees along a steep rainfall gradient across the Isthmus of Panama. We monitored liana and tree growth and sap flow, and measured seasonal physiological responses and leaf traits (N and C content, $\delta^{15}\text{N}$, $\delta^{13}\text{C}$, LMA, gas exchange, and water potential) in co-occurring lianas and trees in a dry, moist, and wet forest. Lianas had stronger

stomatal control and higher water use efficiency than trees in the drier forest, but not the wet forest. Greater leaf-level seasonal resource use strategies and growth during the dry season supports the dry season growth advantage hypothesis and may explain why lianas peak in abundance in seasonally dry tropical forests.

O15 - Are functional traits related to phenological shifts of plants on a global scale?

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Climate change affects plants in their phenology. It has been shown that especially the generative spring phenology like start of flowering shifted to earlier dates within the last three decades. In most regions of the world except for dry regions, this has been shown to be usually related to increasing spring temperatures and changes in growing degree days caused by climate change. Furthermore, model studies predict even an amplification of the earlier start in such spring events.

The longtime observations also show that the phenological reaction differs across plants. Some show stronger shifts, some weaker and some no shifts at all. In very species, spring phenology even shifted to later dates in the year. Plants with very little or no adaptations to climate change are expected to be at a disadvantage. However, factors causing these species-specific reactions are not clearly identified yet.

We aim to detect the processes and factors leading to the different reactions in phenological shifts applying a meta-analysis on a large set of species within the northern hemisphere. We hypothesize that beside climate and local site conditions also biotic factors such as functional traits provide plants with the ability to shift their phenology and therefore become “winners” or “losers” of climate change. We use literature information on phenological shifts of 633 species originating from different biomes of the world. We further use bioclimatic information, shifts in several climate variables as well as several plant functional traits out of trait databases like TRY and LEDA to explain the observed shifts in species phenology within a machine learning based regression approach. Unravelling differences in the phenological shifts of plants with respect to their functional traits contributes to the understanding of ongoing and predicted large-scale biodiversity shifts in responses to climate change.

O16 - A comparison of phenological models for the prediction of leaf-out dates in European tree species

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Spring phenology of temperate forest trees is optimized to maximize the length of the growing season while minimizing the risk for freezing damage. The release from winter dormancy is environmentally mediated by species-specific responses to temperature and photoperiod. Over the last decades a considerable number of models have been developed in order to explain the inter-annual variation of for spring phenology in trees. Contrary to empirical models, “process-based” phenology models aim at simulating underlying physiological processes in order to yield more realistic predictions of growing season onset dates. Despite the increasing knowledge on the environmental controls of seasonal dormancy in trees, the detailed action and interaction of the involved drivers (chilling, photoperiod and warm temperature) remains to be elucidated. Using extensive cross-validation, a uniform comparison of a wide range of existing “process-based” models (and new recombinations) on a multitude of long-term observation series in six tree species across central Europe revealed a surprisingly similar prediction quality for leaf unfolding dates, despite the contrasting model structures. The lowest sites specific prediction errors (RMSE) ranged from 4 to 6 days depending on species; with a low variation between different models. Spatial transfer of site-specific parameters was associated by almost doubling of the average prediction error, independent of transfer distance. Using complementary data from photoperiod and temperature manipulation experiments, allowed estimating the model’s prediction quality under possible future conditions. The findings challenge the accurate implementation of the underlying physiological processes in the models and highlight shortcomings associated with model parameterization on observational time-series only.

O17 - Roe deer browsing induces changes in phytohormones, primary metabolites and defense chemistry in beech and maple saplings

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Deer browsing is one main type of herbivory on tree saplings in forests and can cause a substantial loss of natural regeneration. However, when compared to insect herbivory, our knowledge about trees’ defense and tolerance mechanisms in response to deer browsing is still limited.

In a field experiment, we studied the response of wild-grown European beech (*Fagus sylvatica*) and Sycamore maple (*Acer pseudoplatanus*) saplings to simulated browsing by i) clipping apical buds, or leaves and ii) additionally applying roe deer saliva to the cut surface. In the saplings’ remaining buds, or leaves, respectively, we analyzed changes in phytohormones, primary metabolites (sugars and amino acids) and defense metabolites (phenolics).

In maple lateral buds we observed a significant increase in jasmonates and cytokinins after clipping. Additional saliva application led to a significant reduction in primary metabolites. In contrast, beech buds mainly responded to simulated browsing with decreased levels of phenolics. In both species' leaves, jasmonates increased after clipping. However, as opposed to buds, clipping of maple leaves induced an increase in sugar and phenolic amino acids, and additional saliva application led to an increased biosynthesis of a variety of phenolics. In beech leaves, additional application of deer saliva led to a significant increase in salicylic acid, but only very minor changes in primary and secondary metabolites.

We conclude that tree saplings not only react to mere tissue loss, but perceive and specifically respond to compounds in mammalian herbivore saliva. Browsing responses seem to follow different mechanisms, ranging from almost non-responsive to changes in primary metabolism to increases in defense metabolites. With our study we hope to contribute to a more mechanistic understanding of induced defense and possible tolerance responses in deciduous trees.

O18 - Thermal imaging reveals massive heat accumulation in flowers across a broad spectrum of alpine taxa

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The success of alpine plants at elevations far above the climatic treeline largely rests upon their small stature and, thus, aerodynamic decoupling from free atmospheric circulation leading to significantly warmer life conditions than those reported by weather stations at the same elevation. Yet, most of these microclimatic benefits of low stature materialize during the day, sunny hours in particular. Inflorescences commonly protrude from the aerodynamically sheltered microenvironment of the foliage canopy and, thus, can be expected to experience a comparatively cooler climate. This raises the question, whether inflorescences have evolved means to enhance temperature around the sexual organs during development. Using a high-resolution thermal camera, we performed a mid-summer field survey in the Swiss Alps at 300 m above the climatic treeline to examine floral temperatures as related to solar radiation and flowering unit diameter, height, brightness of flowering units and their area density across a sample of 43 alpine species. We show that flowers of alpine species are actually warmer (mostly 3 K) rather than cooler than canopy foliage on bright days. The degree of heating largely depends on solar radiation, with flowering unit diameter and their area density as significant co-factors. Only in cushion plants, we found flowers to be slightly cooler than the compact leaf canopy. Abrupt shading of flowers revealed the dynamics of heat loss, with two thirds of the extra heat lost in about two to three minutes. We evidence that the size and shape of alpine flowers overcompensate the expected negative effects of greater wind exposure on

experienced temperature as long as the sun is out. The thermal conditions for floral processes are, thus, not much different from lower elevation conditions during good weather. The remaining reproductive constraints are related to the duration of such favourable periods and season length in general.

O19 - Facilitated re-establishment of matrix vegetation after encroachment by *Senna reticulata* in Amazonian floodplains

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In man-made open grasslands in Amazonian floodplains, encroachment by the monodominant shrub *Senna reticulata* takes place. This is a native fast-growing woody plant locally called “pasture killer”. The aim of the present study was to determine the impact of encroachment by *S. reticulata* on plant diversity and the development of successional stages in case of dominance of *S. reticulata*. We document the influence of this native but locally invasive species on woody plant diversity and on the development of deforested areas. The main hypothesis is that there is a difference in species abundance, diversity, composition and biomass between *S. reticulata* stands aged 2 and 6 years, and that with increasing stand age there is an increase in species abundance, diversity and biomass. This way, *S. reticulata* facilitates the establishment of highly diverse forests via encroachment. We screened several farmlands in the vicinity of Manaus, Brazil, for different successional stages of *S. reticulata* stands. We determined all woody plants in plots dominated by *S. reticulata*, two years and six years old. Our results showed that in the first two years *S. reticulata* is highly encroaching and forms almost monodominant stands by outshading other species including competing C4 grasses. However, within only six years, it leads to a positive balance for native species diversity and facilitates the re-establishment of the matrix vegetation leading to similar vegetation composition and structure like by typical successional sequences. We could show a good example for recent statements that the commonly established link between shrub encroachment and degradation is not universal. The ecosystem was ecologically enhanced by encroachment as it facilitated the re-establishment of the matrix vegetation within less than a decade. In a highly dynamic nutrient-rich wetland environment like Amazonian whitewater floodplains, the development of vegetation changes and successional sequences back to the forest matrix are much faster than in systems where water and nutrients are clearly limiting. This desirable development from an ecological and conservationist perspective however is not necessarily a positive outcome for the local farmers whose intention is the maintenance of open grasslands for the

purpose of cattle ranching.

O20 - Paradigm lost: stomatal penetration by aqueous solutions makes aerosol pollution become detrimental for trees

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The paradigm which excluded stomatal penetration by aqueous solutions has meanwhile been disproven by many experiments. Its major shortcoming was the underlying assumption of clean leaves. Leaf surfaces are not clean; they are an important sink for aerosol deposition, and air pollution increases the accumulation of leaf surface particles.

Pine and beech seedlings were grown in ventilated greenhouses with either filtered air or ambient air, and under a rainout shelter. Gas exchange, sap flow, minimum epidermal conductance, and foliar carbon isotopes were determined. The amount of deposited particles was quantified by leaf washing. Leaves were viewed under changing humidity in an environmental scanning electron microscope (ESEM).

Transpiration and minimum epidermal conductance increased with the number of particles attached to the leaves, while water use efficiency decreased. The reaction of stomatal conductance to vapor pressure deficit changed under particle exclusion. The ESEM images and videos indicated the formation of liquid water considerably below 100% relative humidity. Salts on pine needles were capable to create the impression of amorphous 'degraded wax'.

The results confirm that deposited aerosols can affect plant water relations including drought tolerance. Promoted by stomatal transpiration, these 'dew condensation nuclei' absorb water vapor, become deliquescent and form concentrated solutions. The surface tension of the solutions decreases with the chaotropicity of the dissolved substances. The solutions eventually penetrate into the stomata and form thin hydraulic connections which may then act as wicks. Liquid stomatal water loss by wicking is not affected by the reduction of stomatal aperture and possibly even remains active when stomata are closed. The presented mechanism links air pollution with plant drought tolerance and has possibly contributed to earlier and recent cases of regional, drought induced tree mortality.

P1 - Breaking open the black box - Using molecular methods to assess changes in soil microbial communities from plant-soil feedback studies.

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Plant-soil feedback is often assumed to occur through accumulation of species-specific mutualists or pathogens in soil occupied by a plant, leading to enhanced or decreased performance of subsequent generations of plants of the same species that occupy the soil. Most plant-soil feedback studies have a conditioning phase, whereby a species is grown in an initial soil with a microbial community that is then 'conditioned' and altered according to the presence of the particular plant species. We tested the assumption that soil microbial communities are altered in a plant species-specific manner, by using terminal restriction fragment length polymorphism (TRFLP) to fingerprint the bacterial and fungal communities occurring in the rhizospheres of 34 plant species used in a plant-soil feedback experiment. We found that 25-30% of variation in microbial community composition was explained by species identity, with large amounts of variation within species. These results suggest that soil microbial communities do not always change in a plant species-specific manner, and raise questions about how feedback effects on plant growth actually arise. Further work using high-throughput sequencing will identify which specific bacterial taxa (if any) change in abundance at each step of a plant-soil feedback experiment.

P2 - Impacts of spring-, summer- and fall drought on root biomass of common Swiss grassland plant species

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Grassland ecosystems are an important component of the European vegetation. Understanding how future changes in precipitation and in particular drought will affect the functioning of European grasslands is, thus, an important question in global change ecology. Studies of drought on root biomass of grassland species have so far come to adverse results. In particular, the role of timing and duration of drought events remains unclear. To overcome this limitation, we designed a large-scale field experiment, where the effects of drought treatments in spring, summer and fall on the root biomass were tested. Specifically, we tested the effects of seasonal drought events on root biomass for two plant species with each in two different varieties (early flowering: *Lolium perenne* L. var. Artesia, *Dactylis glomerata* L. var. Barexcel; late flowering: *Lolium perenne* L. var. Elgon, *Dactylis glomerata* L. var. Beluga). To study the interacting effects of seasonal drought and plant physiological stages (flowering, non-flowering), two very early and two very late flowering varieties were tested in our factorial design. In our poster we will show first results of the seasonal drought impacts on root biomass of the 2014 growing season.

P3 - How much is too much? Critical load of nitrogen for a coastal heath

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Atmospheric deposition of reactive forms of nitrogen (N) is one of the most important drivers of global biodiversity loss, particularly in N-limited environments, and increased considerably due to anthropogenic activities during the last decades. To better assess the effects of airborne N loads on the functioning of semi-natural and natural ecosystems the “critical load concept” has been established. In the present study, we conducted a two-year field experiment on the island of Fehmarn (Germany) to verify the applicability of this concept for coastal heaths, according to which the critical N load amounts to 10 to 20 kg N ha⁻¹ yr⁻¹. The current background deposition in the study area is about 5 kg N ha⁻¹ yr⁻¹. We applied six different N treatments with concentrations of 0, 2.5, 5, 10, 20, and 50 kg N ha⁻¹ yr⁻¹ (as NH₄NO₃). We quantified current year shoot’s increment and flower production of the dominant dwarf shrub *Calluna vulgaris*. Additionally, we measured biomass C:N ratios. N concentrations of lichens and mosses increased significantly, resulting in a decrease in C:N ratios, at total inputs higher than 25 kg N ha⁻¹ yr⁻¹ in the first year. In the second year the increase in N concentrations of lichens were already significant at total deposition rates of 15 kg N ha⁻¹ yr⁻¹. In contrast, *Calluna vulgaris* showed no significant changes of N concentrations, but the number of flowers increased slightly at inputs of 50 kg N ha⁻¹ yr⁻¹. Current year shoot’s increment was stimulated when experimentally enhanced N inputs exceeded a threshold of 5 kg N ha⁻¹ yr⁻¹. Our findings suggest that coastal heaths might respond more sensitively to airborne N loads than predicted by the critical load concept. However, due to the short-term application of our treatments our findings do not allow for the assessment of probable long-term effects of N loads on the functioning of coastal heaths.

P4 - Water use characteristics of tropical bamboos and trees

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Bamboos (Poaceae) are widespread and play an important role in tropical and subtropical natural forests and land use. Yet, very little is known about their water use characteristics. We asked whether bamboos and trees show differences in daily sap flux patterns and in their response of sap flux densities to environmental drivers. Four bamboo species (*Bambusa vulgaris*, *Dendrocalamus asper*, *Gigantochloa atroviolacea*, *Gigantochloa apus*) and three tree species (*Shorea leprosulla*, *Gmelina arborea*, *Hevea brasiliensis*) were studied in a common garden

in Bogor, Indonesia. Five fully sun-exposed bamboo culms (diameter from 7 to 15 cm) or tree stems (diameter from 15 to 34 cm) were selected for each species. For the assessment of sap flux densities, we used Granier-type thermal dissipation probes (TDP). For bamboos, a method test with the stem heat balance and a gravimetric method suggested the applicability of the TDP method and new species-specific sap flux equations were derived and applied. For trees, we used the standard Granier calibration. Sensors were installed at 1.3 m and at 6 m height. Maximum sap flux densities observed at the lower measurement level were on average two times higher in bamboos than in trees. Normalized sap flux densities did not show significant differences between bamboos and trees in response to VPD and radiation. Bamboos appeared more sensitive to decreases in soil moisture than trees, as long as all of them were fully leaved. However, rubber trees (*Hevea*) shed leaves in the dry season and consequently strongly reduced sap flux densities. During morning hours, sap flux densities in bamboos reached maximal values 50 minutes earlier than trees. The duration, in which 90% of the maximum was maintained, was 18% lower in bamboos than in trees. In both, in bamboos and in trees, the maximum sap flux density was reached earlier and lasted longer (19%) at the upper position of the culm/stem than at the lower position. This raises our interest in assessing the role of internal water storage also in bamboos.

P5 - Water use of oil palms: calibration of a sap flux method and first results

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Oil palm (*Elaeis guineensis*) is one of the most rapidly expanding crops in the world and induces profound land use transformations in tropical lowlands. It is argued that the high yields go along with high water consumption rates. Our objectives were to assess the water use for transpiration by oil palms. In a first step, we calibrated a standard sap flux method in the laboratory and then monitored sap flux densities in an oil palm plantation in the lowlands of Jambi, Indonesia. Granier-type thermal dissipation probes were installed in the leaf petioles, where the density of vessels is much higher than in the trunk. For calibration, we used a gravimetric method. The herewith obtained dataset was split into two halves, one for establishing a new equation and the other for a quality test. The classical Granier equation estimated 17% higher values than the gravimetric approach; the newly established equation yielded statistically acceptable results. In the field, we equipped ten eight-year-old oil palms each with four sensors (one sensor per leaf) and monitored the sap flux for six months. The water use per palm was estimated by counting the leaves per palm and extrapolated by the number of palms on a unit

of land. Our preliminary results suggest that this plantation used on average 1.7 mm water per day for transpiration, which we regard a moderate value. Future studies will also address water use efficiencies.

P6 - Examining variation and heritability of drought stress tolerance in *Abies alba* Mill. seedlings by using terahertz time-domain spectroscopy

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Prognoses by the Intergovernmental Panel on Climate Change (IPCC) indicate a future increase of mean temperature and extreme meteorological events in the Mediterranean area and central Europe. Silver fir (*Abies alba*) is a forest tree, which is sensitive to drought stress. Since this species requires a high amount of moisture, the next decades might become a challenge. To develop future conservation measures, we urgently need to achieve a better understanding of how silver firs react to drought stress. In the present study we investigated how seedlings from contrasting environments differ in their drought stress response and how this response varies within and between populations. Furthermore, we were interested whether drought stress tolerance is a heritable trait. For the experiments we used silver fir seedlings originating from three localities in Austria with different precipitation and different annual annual temperature. Within each locality four single tree progenies were sampled. Signs of drought stress such as withering cannot be visually assessed in silver fir seedlings due to the solid anatomy of the needles. Therefore, we used terahertz time-domain spectroscopy to precisely monitor the water content of water deprived silver firs in real-time. We determined a time curve for the water loss of every seedling. Furthermore we narrowed down the amount of water loss which causes fatal damage to the plants, i.e. the permanent wilting point. To assess the heritability of drought stress response and tolerance, relatedness among seedlings was analyzed using microsatellite markers. First results are presented and discussed.

P7 - Grazing as an environmental filter for plant functional traits in European continental grasslands

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A fundamental step in advancing predictions in plant ecology is to identify the key functional traits that allow species to occur under strong environmental filtering conditions. Grazing can be considered such a filter, rangelands often differ in species composition from grasslands of other land use types (mowing, abandoned etc.). Assessing the impact of grazing has gained importance over the last decades as land-use change are now considered the most important drivers of biodiversity loss and ecosystem changes worldwide. Grazing is a combination of selective defoliation, trampling damage and faeces disposal, inducing changes in trait composition through shifts in the relative abundance of species and species turnover. So far, most studies have focused on particular components of grazing (e.g. intensity, selection of herbivores or seasonality) on single selected traits. Our aim is to increase our knowledge understanding on how traits combine based on an comprehensive set of aboveground traits. We made use of the vegetation surveys in the managed grasslands in the German Biodiversity Exploratories (www.biodiversity-exploratories.de), recorded in the Schorfheide, Hainich and Schwäbische Alb over a period of five years. These grasslands represent a long gradient in grazing intensity, and also vary with respect to type of grazers, seasonality and fertilization. In addition, the impact of grazing can be compared with the alternative forms of land use (mowing) and combinations with mowing. We obtained the traits from own measurements (SLA, LDMC and height), complemented by trait databases and literature (Bioflor, LEDA, Biopop and Rothmaler).

END OF SESSION 13

Session 14 - Plant volatiles

CHAIRS: SYBILLE UNSICKER, ROBERT R. JUNKER

O1 - Plant-plant signalling and other volatile-mediated effects in the biocontrol of pests and pathogens

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Plants respond to herbivore attack or the infection by pathogens with changes in the emission of volatile organic compounds (VOCs). Among many other organisms, predators and parasitoids can use these VOCs to localise their herbivorous prey insects and neighbouring plants can perceive VOCs as 'danger signals' and prepare their own defences accordingly. Although these effects frequently have been discussed as promising tools for biocontrol, examples of their successful application are scarce. Here I discuss that plants that emit the corresponding VOCs without carrying herbivores would emit dishonest signals and, thus, rapidly cause counter-responses by animals at the third trophic level. However, the combination of information-based interactions (VOCs) with resource-based interactions mediated by, e.g., extrafloral nectar, represents a promising perspective to solve this dilemma. Resistance induction by plant-plant signalling appears to be a promising tool in the control of disease, particularly when some of the VOCs also exhibit direct effects on the pathogens. We have recently demonstrated that VOCs from bean (*Phaseolus vulgaris*) cultivars with high basal resistance to fungal anthracnose (caused by *Colletotrichum lindemuthianum*) enhance the resistance to this pathogen in neighbouring plants of a susceptible cultivar via both mechanisms: the priming of resistance genes in the receiver and direct inhibitory effects on fungal development. VOCs mediate multiple ecological effects in the natural ecosystem and all of these functions must be considered to successfully use VOCs in the environmentally friendly control of pests and pathogens.

O2 - Floral microbial ecology - bacterial colonization is controlled by and alters floral scents composition

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The composition of floral scent bouquets is assumed to be result of stabilizing or directed selection by pollinators and floral antagonists. Like all plant surfaces, flowers are colonized by microorganisms including bacteria, yeast and other fungi. Acknowledging the presence of microbes on reproductive tissues, we are currently testing the following hypotheses: 1.) Bacterial colonizers are often not commensalists but have positive and negative functions related to plant reproduction. 2.) Flower volatiles have both growth inhibiting properties but also

serve as carbon source for bacteria. 3.) Bacteria metabolize volatiles emitted by flowers leading to altered floral scent phenotypes. 4.) Bacteria select for floral scents and thus need to be considered in the context of floral evolution.

Our data support hypotheses 1-3 and thus suggest that bacteria are driving forces in floral evolution (4). We were able to demonstrate that bacteria have the potential to decrease interaction frequencies with pollinators. Floral scents turned out to be Hutchinsonian niche dimensions for bacteria that determine the presence or absence of bacteria on plant surfaces by inhibiting the growth of some but provide carbon for other strains. Furthermore, in culture experiments we demonstrated that bacteria nearly deplete available volatiles, emit novel substances (depending on the medium) and thus may cause ecologically relevant changes in floral scent bouquets.

Our results provide novel insights into the volatile-mediated interactions between flowers and bacteria and strongly suggest that bacteria have profound effects on floral ecology and evolution.

O3 - Functional diversity of flower signals along an altitudinal gradient under consideration of the sensory physiology of flower visitors

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Plant-insect communities vary along altitudinal gradients in their species composition as well as diversity. For instance, flies dominate flower visitor communities in higher altitudes, whereas bees are more common in lower areas. To investigate the underlying principles of such distributions, we observe flower-visitor interactions and characterise floral phenotypes (scent bouquets, colour and morphology) of plants at different sites along an altitudinal gradient exploring the shifts in functional flower traits and the functional diversity within and across plots. Furthermore, we identify volatiles within floral scent bouquets that can be perceived by different flower visitor taxa (GC/EAD) and model species-specific quantum catch based on floral colours. Using this information, we test the following hypothesis: 1.) Floral phenotypes within sites are adapted to the prevalent flower visitors. 2.) The functional diversity – based on the floral phenotype of plants – is dependent on the flower visitors' equipment with olfactory and visual receptors because these contribute to a species-specific perception of scents and colours.

Different flower visitor taxa perceived distinct but overlapping sets of volatile organic compounds emitted by the flowers in the communities. Additionally, interspecific differences of flower colours were dependent on spectral sensitivity of their photoreceptors. These findings allowed us to introduce the concept of "taxon-dependent functional diversity", reflecting the subjective distances between floral

phenotypes based on flower scent and colour. By further exploring this novel concept we may be able to obtain deeper insights into the co-evolution of flowers and their visitors mediated by floral signals.

O4 - How can emission patterns help us elucidate the ecological roles of plant volatiles?

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Herbivore-induced plant volatiles attract natural enemies mediating indirect plant defense. Volatile emission is a dynamic process which can be strongly influenced by biotic and abiotic factors such as herbivory and photoperiod, but so far these effects have only been explored in a few plant species (mostly cultivated annuals). We investigated the effect of factors such as: time of herbivory, herbivore identity and developmental stage, feeding amount and photoperiod on the volatile emission of a woody perennial species (*Populus nigra*), in order to make inferences about the ecological roles of individual compounds. We found that emission dynamics are similar for compounds within the same chemical class, but individual compounds might react differently to biotic and abiotic factors. Some compounds are released immediately upon herbivore attack or shortly afterwards, irrespective of light conditions and cease to be emitted shortly after herbivore removal so they could be reliable indicators of herbivore presence for natural enemies e.g. nitrogen containing compounds (aloximes), green leaf volatiles, and the aromatic salicylaldehyde. The amount of feeding has a significant effect on the emission of the majority of compounds investigated, showing that volatile emission could be a reliable indicator of prey density as well. Only few compounds differed between the induced profile of two caterpillar species in their late developmental stages (*Lymantria dispar* and *Laothoe populi*), and between mixed herbivory by both species vs. single species herbivory. However, the developmental stage of the herbivore had a strong impact on volatile emission, early instar *L. dispar* induce significantly more nitrogen-containing volatiles and terpenoids than late instar *L. dispar* and *L. populi* suggesting that these volatiles inform natural enemies about the developmental stage of the herbivore. The emission patterns of minor N. compounds (aloximes) suggest that they could be reliable cues for natural enemies, informing about herbivore presence, identity, developmental stage and density.

O5 - Insect attraction to herbivore-induced beech volatiles under different forest management regimes

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Insect herbivore enemies such as parasitoids and predators are important in controlling outbreaks of herbivore pests. From agricultural systems we know that land-use intensification can negatively impact biological control as an important ecosystem service. However the mechanisms of biological control in differently managed forests are poorly understood. The aim of this study was to investigate the importance of management regime for natural enemy pressure and biological control possibilities in forests dominated by *Fagus sylvatica*. Therefore, flight interception traps were installed next to *Lymantria dispar* caterpillar infested young beech trees releasing herbivore-induced volatiles and next to non-infested control trees. Significantly more parasitoids were captured next to caterpillar-infested beech phytometers compared to non-infested control trees. This pattern was observed irrespective of forest type although the composition of the trophic guilds in the traps did vary in response to forest management regime. Our data show that herbivore-induced beech volatiles attract herbivore enemies under field conditions. It further suggests that differences in structural complexity of forests as a consequence of management regime only play a minor role for parasitoid activity and thus for indirect tree defense.

P1 -Volatile-mediated communication in black poplar trees

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Upon insect herbivore attack, plants release a specific blend of volatile organic compounds. These herbivore induced volatiles (HIPV) are known to play an important role in direct and indirect plant defense and can furthermore function as signals in plant-to-plant communication. Plants previously exposed to herbivore induced volatiles may be primed to increase their induction of defenses after a second bout of herbivore feeding. Such priming of defense induction has been described for a number of herbaceous species such as maize, tobacco, lima bean and poplar, but so far the individual compounds responsible for volatile mediated defense priming remain unknown.

The goal of this project was to determine if HIPVs released from black poplar (*Populus nigra*) prime anti-herbivore defenses in neighboring trees. Furthermore, the role of individual HIPVs as signaling molecules in inter-tree communication was

investigated. Short term dynamics in volatile emission of herbivore infested trees with and without previous contact to the full blend of HIPVs and individual compounds were measured online with a Proton Transfer Reaction - Mass Spectrometer (PTR-MS).

END OF SESSION 14

Session 15 - Ready for epigenetics in ecology?

CHAIRS: KATRIN HEER, LARS OPGENOORTH

O1 - Conservation of the heritable DNA methylome in different natural environments and varying growth conditions

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Heritable epigenetic polymorphisms, such as differential cytosine methylation or histone modifications, can underlie phenotypic variation. There has recently been a heated debate on whether environmental effects can lead to heritable epigenetic pattern changes that might drive acclimation and ultimately influence selection processes and adaptation. Comprehensive data on the establishment and transgenerational stability of epigenetic marks has, however, remained scarce. The focus of our research is the spectrum and frequency of DNA methylation variation, both arising spontaneously and being induced by external factors. When studying epigenetic variants it is imperative to discriminate them from confounding genetic polymorphisms, which is facilitated in the model plant *Arabidopsis thaliana*. To understand the degree of epigenetic variation in natural populations exposed to different environments, we have selected a set of near-isogenic lines from North America. *A. thaliana* has presumably been introduced to the American land mass in the course of human settlement and has thus passed through a severe population bottleneck in the very recent past, leading to reduced genetic diversity. We performed whole-genome, -methylome and -transcriptome sequencing on accessions of the common North-American haplogroup1 (HPG1). Epigenetic polymorphisms accumulated at similar rates and to a large extent at identical loci compared to lines grown in greenhouse conditions. This indicates that certain loci are highly susceptible to changes in methylation state, independent of genetic background and growth conditions. We conclude that heritable epigenetic variation is only marginally controlled by external factors and largely consists of spontaneous changes accumulating over time.

O2 - A model plant system demonstrates the potential ecological and evolutionary significance of epigenetic variation

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Although there is currently great interest in the ecological and evolutionary significance of epigenetic variation, very few solid empirical tests of it exist. One reason for this is that genetic and epigenetic variation are usually confounded in natural populations, and it remains difficult to disentangle their effects on phenotypes. A rare opportunity to overcome this problem, and thus to unambiguously test for the effects of epigenetic variation, are epigenetic recombinant inbred lines (epiRILs) of *Arabidopsis thaliana* which are nearly isogenic but differ strongly and heritably in their genome-wide patterns of DNA methylation. We have used this system in a series of proof-of-principle experiments testing the ecological and evolutionary consequences of epigenetic variation. We combined quantitative genetic methods with experimental evolution to show that the DNA methylation variation among epiRILs indeed causes substantial heritability of ecologically important traits, and that this variation allows rapid shifts in phenotype and epigenotype composition over few generations of quasi-natural selection. Moreover, we found that epigenetic diversity, just like genetic diversity, can increase the productivity and stability of plant populations. Taken together, our studies provide proof-of-principle that epigenetic variation alone can have strong effects on the ecology and evolution of plant populations.

O3 - Cytosine methylation: a versatile epigenetic mark for phenotypic adaptation

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Eukaryotic species use cytosine methylation to facilitate phenotypic adaptation to their environments, which can include both the modulation of developmental and adaptive gene expression programs. Variations in the complement of cytosine methyltransferase enzymes have been interpreted to reflect multiple versions of a toolkit for phenotypic adaptation. During evolution, specific parts of this toolkit could have been contracted or expanded to facilitate specific requirements for genome regulation. We are investigating this hypothesis in several independent models. For example, the methylation landscapes of human and mouse genomes, are characterized by high developmental plasticity, but substantial stability towards environmental changes, consistent with the highly canalized phenotypes of mammals. Other organisms (honeybees, locusts, crayfish), however, show a substantially higher degree of phenotypic plasticity. We are using whole-genome sequencing technologies to establish genome methylation maps of various model systems at single-base resolution and an overview of the results will be presented. Furthermore, several organisms have lost canonical DNA methyltransferase genes, and utilize the Dnmt2 enzyme for tRNA methylation. Our previous studies have established RNA methylation as a novel epigenetic mechanism that provides specific advantages in the short-term adaptation to environmental changes. The significance of this mechanism for epigenetic regulation will be discussed.

O4 - Parental effects increased the competitive ability in a semi-arid annual Brassicaceae

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Parental effects (PE) can improve offspring performance under particular environmental conditions. However, studies on wild plant populations are few and largely neglected the role of neighboring plants.

Here, we tested for higher competitive ability in offspring when parents were grown under favorable water conditions (PE 'favorable') and explain why this might evolve in certain ecosystems. Simultaneously we tested for improved drought resistance in offspring when parents were grown under drought conditions (PE 'drought'). We expected a trade-off between competitive ability and drought resistance.

Biscutella didyma, a semi-arid annual Brassicaceae, served as target species. Offspring with PE 'favorable' and PE 'drought', respectively, was grown with and without neighbors under six irrigation levels in order to apply a range of contrasting competitive and drought conditions.

Targets with PE 'favorable' produced substantially more seeds than targets with PE 'drought' when they were grown under neighbor competition. This was associated with subtle changes in phenology. However, seed production or any other parameter did not differ when plants were grown without neighbors. Moreover, there was no evidence for increased drought resistance in plants with PE 'drought'.

Our results showed a so far unrecognized type of adaptive PE: parents induced increased competitive ability in their offspring. We argue that this pathway may evolve especially in ecosystems with strong temporal variation in environmental favorability and competition intensity. Our results also call for including neighboring plants in future studies of parental effects for realistic assessments of offspring performance.

O5 - Transgenerational plasticity causes home-site advantage in a multi-generation reciprocal transplant experiment under natural conditions

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Epigenetic variation lately became a topic of great interest due to its potential role in adaptation. Adaptation via epigenetic modifications may happen through stable epigenetic alleles that modify the phenotype and may be exposed to selection. In addition, a plastic response of the parent plant may be transmitted to the offspring thereby causing a better adaptation of offspring to the parental environment. The

later phenomenon is also called transgenerational plasticity and is the focus of our experiments. We conducted two multi-generation reciprocal transplant experiments including several accessions of *Arabidopsis thaliana*. The first experiment included three stress treatments (simulated herbivory (clipping), shade, cold/warm treatment) with three diverse genotypes. The results suggested that offspring of stressed plants were better adapted to stress conditions in the case of clipping and shading or showed a genotype \times parental stress interaction in the temperature treatment. All parental effects were stress-specific as they were not observed under control conditions.

In the second experiment, we cultivated 16 diverse genotypes in two sites at different altitudes (400 m and 700 m) for two years. In the third year, the offspring were reciprocally transplanted revealing strong differences in fitness due to the parental environment accompanied with up to 30 days flowering time differences. Averaged across genotypes, we discovered the classical home-site advantage suggesting adaptation to the parental environment caused by the parental experience of the site – not by selection. In addition to these results, we will present results from an ongoing whole genome methylome sequencing analysis of the second experiment aimed to identify loci with systematically differentiated cytosine methylation. Since non GC-methylation may influence gene expression and may be transmitted across generations, we expect that it contributes to the observed transgenerational plasticity.

O6 - Stay high or get low: can epigenetic variation lead to recurrent speciation?

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Across heterogeneous environments, variation in biotic and abiotic conditions and in the resulting selective pressures often leads to the formation of ecotypes, i.e. distinct populations adapted to their specific habitat. An interesting example for recurrent independent formation of ecotypes is found in mountain plant *Heliosperma pusillum* s.l. (Caryophyllaceae). Within this group, the lower elevation *H. veselskyi* is a perennial species with a dense sticky indumentum, which inhabits rock overhangs and shallow caves with poor light conditions below the timberline, whereas its closest relative, the alpine *H. pusillum*, is glabrous and occurs on creeks and moist calcareous screes. This phenotypic differentiation remains stable in offspring grown from seeds in a common garden at least across three generations. Reciprocal transplantations show that *H. pusillum* has higher germination rates in both habitats, but only in the alpine one its growth parameters are higher than for *H. veselskyi*. Although they have been both described at species rank because of their distinct morphology, molecular data (for example over 2,200 informative SNPs filtered from NGS-based restriction site associated DNA sequencing – RADseq)

surprisingly show that the two species are intermixed, suggesting a recent and recurrent origin of *H. veselskyi* from *H. pusillum*. Moreover, individuals of both ecotypes stemming from one mountain range are genetically more similar than individuals of the same ecotype from different mountain ranges. This suggests that they are ecotypes, resulting from middle- to short-term adaptive processes, perhaps under the influence of the environment and independent (yet!) of actual changes in DNA sequence. We present preliminary results based on bisulfite RADseq to test for genome-wide differences in DNA methylation correlated with the striking phenotypic differentiation between high- and low altitude populations and discuss here the possible role of epigenetics in the initial phase of divergent evolution. In the light of our results a likely evolutionary scenario for this group appears to involve environmental disruption of gene expression levels, which have independently converged to similar, stable phenotypes through repeatable effects of natural selection in similar environments.

O7 - Exploring the causes and consequences of natural epigenetic variation in plants

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Plant lineages that have little genetic variation, such as clonal species or completely inbred sexual genotypes, are well-suited for exposing the effects of epigenetic variation that is not confounded with genetic differences. We study epigenetic variation in asexual dandelion lineages, with the ultimate aim to explore if (or how) epigenetics contributes to adaptation in asexual lineages. Using examples from our work I will discuss two different aspects of heritable epigenetic variation: epigenetics as an underlying mechanism of transgenerational phenotypic plasticity (or transgenerational effects), and stable but essentially random epigenetic variation that may be shaped by selection. With respect to the first, we explore transgenerational effects of biotic and abiotic stress exposure at the DNA methylation, transcriptome, metabolome and trait levels. With respect to the second, we explore patterns of standing heritable epigenetic variation in natural populations and between clone members within widespread apomictic dandelion genotypes. These studies can yield first insights into the role the epigenetic variation plays in the wild.

END OF SESSION 15

Session 16 - Evolutionary ecology

CHAIRS: OLIVER BOSSDORF, MARK VAN KLEUNEN

O1 - Genetic variation of commercial Regiosaatgut accessions of grassland species: species specific or consistent patterns across species?

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In Germany local seed-source provenances of grassland species have been delineated according to major natural regions with similar geographic (e.g. geomorphological) conditions. The system of source regions is valid across all species and not species specific. We ask whether and how source regions are genetically differentiated and whether patterns of genetic differentiation are consistent across species. We investigated commercial seeds of 7 common grassland species from 8 German source regions (Regiosaatgut) using AFLP markers and quantified genetic differentiation by AMOVA and cluster analysis and performed tests of isolation by physical or climatic distance. Accessions were significantly genetically differentiated for almost all pairwise comparisons except for the only grass species investigated (*Arrhenatherum elatius*). Overall F_{st} values ranged between 0.05 in *Arrhenatherum* and 0.34 in *Knautia arvensis*. Bayesian cluster analyses detected between 1 and 7 hierarchical clusters across the species indicating species specific spatial genetic structure. Isolation by distance (IBD) was found in four species. As expected, genetic differentiation patterns were consistent and correlated among species only for those species that showed significant IBD. This suggests that the non-species-specific delineation of source regions is consistent with genetic variation patterns, at least at the spatial scale investigated. In addition we detected geographic patterns of two cytotypes in *Knautia arvensis* and putative introgressive contamination with cultivars in *Daucus carota*. Results will be discussed with respect to parallel phenotypic investigations and the Regiosaatgut concept as a whole.

O2 - Regional adaptation among seed origins used for grassland restoration: results from a multi-species reciprocal transplant experiment

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One of the key questions in ecosystem restoration is the choice of seed materials for restoring plant communities. More and more scientists and practitioners are

currently advocating the use of regional seed sources, based on the argument that plants are often adapted to local or regional environmental conditions, so that regional seed sources should provide the best restoration success. However, there is still substantial debate on this approach, partly because we do not have enough sound empirical tests of it. Here, we conducted a multi-species reciprocal transplant experiment in which we compared the performance of eight seed origins of each of seven plant species commonly used in grassland restoration in four experimental sites across Germany. We found that, on average, plants of regional origins produced 30% more inflorescences and 8% more biomass than those of foreign origins. Although there were great differences among species in the strength of these effects, we found that in most of the studied species, fitness indeed decreased with increasing geographical distance, as well as with increasing climatic differences between plant origins and experimental sites. In addition to these effects on plant fitness, we also found increasing differences in plant phenology with increasing geographical or climatic distance. Since phenology is important for biotic interactions, especially with pollinators or seed predators, this suggests that using foreign seed sources may have cascading negative effects on local ecosystems. Indeed, inflorescences of *Centaurea jacea* from different origins differed in their probability of being attacked by seed herbivores, and these differences were related to phenology. In summary, our study provides strong evidence that genetic differentiation and local adaptation is common in seed materials used for grassland restoration, and that using non-regional seed sources will not only decrease the performance of the plants but also affect their biotic interactions.

O3 - Habitat fragmentation and trait evolution: Are plants able to respond to altered selective pressures?

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Habitat fragmentation may affect trait evolution in plants through changes in the environment. Evolutionary change, however, may be limited when fragmented populations suffer from genetic or environmental deterioration. In this study, we examined the potential of plants in fragmented populations to respond to altered selective pressures by estimating the amount of heritable variation in several phenotypic traits, using *Phyteuma spicatum* as study species. We grew offspring of plants of ten natural populations of varying size under common environmental conditions and assessed if population trait means or heritability estimates were related to the size and abiotic environmental conditions of the populations of origin. All traits differed significantly among populations and maternal families, suggesting that genetic effects were responsible for the observed trait variation. Narrow-sense heritabilities (h^2) ranged between 0 and 1.13, depending on trait and population of origin. Size and / or environmental conditions of the populations of

origin affected means and h^2 -estimates of some of the measured traits. Heritabilities for flowering duration and mean seed mass decreased with decreasing population size, suggesting that plants in small populations may have a reduced capacity to respond and adapt to changes in the environment which alter selective pressures on these traits. Knowledge about the adaptive potential of small plant populations is important if we want to understand how habitat fragmentation and associated changes in the environment affect trait evolution.

O4 - Adaptive divergence in functional traits of a widespread wetland plant

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In wetland ecosystems the interaction between plants and rhizosphere community determines retention and the natural degradation of contaminants and thus an important ecosystem function. Knowledge on the evolutionary potential of functional traits relevant for this interaction can help to assess how changing selective drivers may affect wetland ecosystem functioning.

The differentiation of functional traits among populations is shaped by the interplay between the neutral processes and adaptive processes. The comparison of differentiation patterns for quantitative traits (Q_{ST}) relative to that of neutral marker loci (F_{ST}) thus allows distinguishing between these processes. Here we investigate functional traits of the widespread wetland plant *Juncus effusus*. It has been established as model in ecological research on wetland ecosystem functioning, however, potentially related intra-specific trait variation within and among natural populations has not been studied so far. We test the hypothesis that genetic differentiation patterns for functional traits relevant for degradation processes differ from neutral expectation, and hence, are the result of selective mechanisms.

We raised seed families from six populations originating throughout Europe in a common garden under two fertilization treatments and measured several traits potentially relevant for the interaction with the rhizosphere community and the degradation potential of nitrogen compounds. Furthermore, we assessed neutral differentiation among provenances using 16 microsatellite markers. Primarily results indicate that most functional traits assessed are significantly differentiated among provenances and show either the imprint of diversifying ($Q_{ST} > F_{ST}$) or stabilizing selection regimes ($Q_{ST} < F_{ST}$). Potential drivers of adaptive divergence might be identified by correlating respective traits against source site characteristics.

O5 - Separation in flowering time contributes in maintaining sympatric cryptic plant lineages

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Sympatric cryptic lineages are a challenge for the understanding of species coexistence and lineage diversification and have major impact on management, conservation and utilization of genetic resources. In higher plants sympatric cryptic lineages are rare as are studies providing insights into the mechanisms leading to, and maintaining such lineages. Here, we show that the common rush *Juncus effusus*, a widespread wetland plant, consists of two genetically distinct lineages that are sympatric but morphologically cryptic. Furthermore, we ask how these lineages are ecologically differentiated and reproductively isolated. Using microsatellites and chloroplast sequence data we found two genetically differentiated lineages, showing substantial overlap in morphological traits and a similar preference for soil moisture content. However, flowering time differed significantly between both lineages likely contributing to reproductive isolation. Moreover, the later flowering lineage suffered less from seed predation by a *Coleophora* moth species suggesting additional selection on flowering time. The understanding of lineage coexistence is further challenged by hybridization of both lineages and with another closely related, sympatric rush species. Chloroplast haplotype sharing of the latter with one of the cryptic lineages suggests a complex evolutionary history in which flowering time differentiation contributes to the maintenance of sympatric lineages.

O6 - The role of non-adaptive evolution and genetic diversity for herbivory resistance in invasive and native field populations of *Silene latifolia*

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The EICA hypothesis has driven research on adaptive phenotypic evolution during biological invasions in the past two decades. Reviews on this research however indicate that the relaxation of selection through natural enemies alone does not explain the phenotypic divergence between ranges. Demographic disequilibrium during invasions often reduces effective size and genetic diversity of natural populations which leads to genetic drift and inbreeding. Such processes may shape phenotypes in addition to contrasting selective forces. However, until today no study on the EICA-hypothesis has taken demographic history and its evolutionary consequences into account.

In this study, we investigated the influence of neutral genetic relatedness (NGR) and genetic diversity on plant performance as well as herbivory resistance related traits in 17 native and 18 invasive field populations of *Silene latifolia*. We conducted microsatellite analyses with 10 primer pairs to determine expected heterozygosity (He) and NGR of the sampled populations. We tested whether the measured responses are related to He and range with animal models that account for NGV and thus non-adaptive evolution.

Our analyses revealed that especially herbivory was strongly influenced by NGV of *S. latifolia* which indicates that random evolution plays a major role for herbivore resistance and host quality. Moreover, our results demonstrate that effects of genetic diversity on plant performance and herbivory differ between ranges.

In conclusion, we suggest that EICA-related phenotypic differentiation is not exclusively shaped by adaptation to contrasting selective regimes but by more complex evolutionary mechanisms that are of relevance even under field conditions.

O7 - The performance of a rare obligate pollination mutualism in the agricultural landscapes of north-east Germany

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The relationship between the European globeflower, *Trollius europaeus* L. (Ranunculaceae), and four to six fly species of the genus *Chiastocheta* (Diptera: Anthomyiidae) is an example of a rare plant/seed-eating pollinator mutualism. This interaction has a long co-evolutionary history and is believed to be obligate, i.e. the plant is not able to survive without the flies and vice versa. Moreover, the globeflower is a threatened species in NE Germany.

The outcome of species interactions can vary in space and time depending on various environmental conditions. However, little is known about the variability and stability of this close mutualistic system in the face of environmental impacts, in particular due to land use in human-dominated landscapes. The aim of our study was (i) to evaluate the variability of pollination success in small host plant populations, (ii) to examine the ecological factors limiting the local and the regional persistence of *T. europaeus*, and (iii) to investigate the demographic performance of this species in order to be able to give advice on conservation options.

Our pollination studies revealed low seed output in small plant populations and an overall larger reproductive variability of the mutualism compared to studies in other regions. The plant is more resilient to human disturbances than the flies, suggesting that the interaction may not be obligate for *T. europaeus*. However, the plant species' local and regional survival is limited mainly by current land use practices, even in nature reserves, and by its low dispersal capacity as revealed by a reintroduction experiment, dispersal simulations, and matrix modeling within this study.

Overall, the complex interplay and stochasticity of land use, weather conditions and the interaction with the fly species makes it difficult to predict evolutionary direction of the entire system. Three scenarios are possible: disbandment of the mutualism, adaptation or linked extinction. For conservation purposes, *Trollius* sites should be mown once or twice a year after maturity, but they should not be grazed.

O8 - Does small-scale pollinator shift drive evolution of functional traits in a specialised pollination system?

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Although the importance of plant-pollinator interactions as a driver of diversification is well known, the evolutionary processes acting within the system often remain uncertain. One approach to identify current evolutionary processes promoting morphological variation within species potentially leading to speciation is a test for covariation of functional traits of strongly interacting species across populations. The studied pollination system contains strongly interacting species of *Diascia* plants and *Rediviva* bees. The *Diascia* flowers have dorsal spurs containing oil as floral reward and differ in shape and length between species. Females of *Rediviva* species have evolved elongated forelegs for harvesting oil as larval food from *Diascia* host plants. The spurs of two long-spurred *Diascia* plants (*D. floribunda* and *D. whiteheadii*) and the forelegs of the most frequent *Rediviva* bees (short-legged *R. nitida*, long-legged *R. macgregori* and *R. longimanus*) were studied across a small geographical scale to test for covariation of functional traits and to identify its driving processes. We found that foreleg length of *Rediviva* and *Diascia* spur length differed significantly between sites and were correlated. Spur elongation was associated with pollinator shift from short towards long-legged *Rediviva* species. The foreleg length of long-legged *R. longimanus* increases with spur length of *Diascia* hosts suggesting coevolutionary processes are acting on functional traits in the *Diascia-Rediviva* pollination system. We conclude that at least two processes (pollinator shift and coevolution) are responsible for

covariation of functional traits in this specialised pollination system and probably operate as main drivers of diversification.

O9 - Eco evolutionary feedback dynamics in host parasite interactions

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Coevolution in host-parasite systems has been studied intensively but most studies did not account for population and community dynamics, therefore overlooking the potential interaction between ecological and rapid evolutionary change. We studied eco-evolutionary dynamics in a host-parasite system by following the ecological and evolutionary change in long-term chemostat experiments with fresh water algae and its viral parasite. Time-shift experiments show that rapid evolution of resistance and infectivity significantly changed the ecological dynamics. Algae evolved rapidly to become resistant against the virus, followed by a counter-adaptation of the virus, and so on. These dynamics are consistent with arms race dynamics and coincide with cycling population dynamics of host and virus. However, the evolutionary dynamics shifted from arms race to fluctuating selection once a generalist host evolved. At this time, population dynamics changed from cycling to steady state dynamics. A trade-off between resistance and reduced competitive abilities prevented fixation of the generalist host and resulted then in the coexistence of multiple host genotypes and the stabilization of the population dynamics. Our study shows the first eco-evolutionary feedback loop with coevolving populations: ecological change in the host population after virus introduction resulted in an evolutionary response of the host (evolution of resistance), with further ecological change (decline in virus population) and subsequent evolutionary change in the virus (evolution of infectivity), and so on. In another set of experiments, we examined how increased complexity of the study system – by adding a predator for the algae -affected eco-evolutionary dynamics. Even though both consumers can coexist with the algae separately, all three species could only coexist after the algae and virus coevolved. Altogether these results highlight the importance of considering the tight link between rapid evolution and ecological change for understanding the dynamics of host-parasite interactions.

O10 - Rapid evolution at the edge: selection on life-history traits during experimental range expansions

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Species' ranges are rarely static. Shifts in species' ranges have been especially pronounced in the context of global climatic changes and other anthropogenic environmental modifications. However, understanding and predicting the dynamics of ranges, which is highly relevant to both basic and applied research, has proven to be difficult.

In principle, population spread can be described as a function of three basic processes, which can be linked by trade-offs: dispersal, reproduction and density-dependence. Empirical evidence and a growing number of theoretical studies suggest that these three processes are subject to rapid evolutionary changes during invasions. This may lead to an acceleration of the population's spread. Yet, experimental evidence that substantiates these claims remains scarce.

We here present experimental evidence for the concurrent evolution of dispersal and other life-history traits – such as growth rate, equilibrium density and morphological parameters – during replicated invasions in microcosms of the ciliate *Tetrahymena* sp. In accordance with previous empirical studies and theoretical predictions we found that invasions select for higher individual velocities and dispersal rates. In addition, experimental invasions also impacted growth rates and fundamentally changed density-regulation within replicated populations. We not only observed that growth rates were higher at expanding range fronts but also found an increase in equilibrium population size. Together, these findings underline that invasion and range expansion cannot exclusively be studied from an ecological perspective, but must include evolutionary dynamics.

O11 - Non-random dispersal and eco-evolutionary dynamics of species invasions

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Understanding species invasions and range shifts is a fundamental challenge in ecology and evolution. Today, we are facing rapid environmental and climatic changes which can cause range shifts and seem to facilitate species invasions. Consequently, range biology is highly relevant for conservation and management.

The geographic position of a species' range and its invasion potential is centrally influenced by the species' dispersal abilities. Dispersal behaviour has now repeatedly been shown to be subject to (rapid) evolution. Thus, well founded knowledge on the eco-evolutionary dynamics of dispersal is essential in order to understand range and invasion dynamics.

Current mechanistic models, which are firmly rooted in the tradition of metapopulation theory, often ignore a possibly important modulator of dispersal evolution and range dynamics, namely information use. Generally, information use is the ability to plasticly respond to biotic or abiotic changes, such as increasing

population densities or shifting local climatic conditions. Taking into account information can be important and highly adaptive during all three phases of dispersal (emigration, transition and immigration).

Using an individual-based simulation framework, we aim to fill this gap. Specifically, we analyse the impact of informed (directional) dispersal during range expansions and invasions on ecological and evolutionary dynamics.

We find that informed and directional dispersal evolves readily during range expansions and that concurrently higher dispersal rates are selected for. These evolutionary changes drastically impact (macro-)ecological dynamics such as the speed of invasions and range border elasticity.

O12 - The evolution of simultaneous progressive provisioning in social vs. solitary insects

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Simultaneous progressive provisioners' (SPP) feed their offspring gradually as they develop; specifically they feed more than one offspring at the same time. In contrast, 'mass provisioners' (MP) sequentially supply offspring one after another. Utilizing individual-based simulations J. Field (2005) compared the life-time reproductive success of these strategies in various scenarios. Accordingly, MP evolves in most of the cases - SPP only has an evolutionary benefit if offspring survival depends on their mothers' shelter until adulthood (even if the provisioning period itself would be shorter). However, this explanation is not fully convincing regarding the dominance of SPP in eusocial colonies of wasps, bees or ants, especially when the brood is protected by workers. We propose an analytical model (fully including Field's approach as a special case) utilizing population growth rate instead of life-time reproductive success as a measure of fitness. Our model shows that multiplicative geometric effects in fitness would typically compensate for demographic disadvantages of SPP (due to prolonged dependency) and consequently support the evolution of SPP over MP for a wide range of life history parameters. The optimal level of SPP (i.e. the optimal number of eggs laid simultaneously) is determined by offspring development time, survival rate, and foraging efficiency of the mother. Only extreme values of these demographic parameters would favor a transition to MP-behavior.

O13 - Reconstruction of two colonisation pathways of *Mantis religiosa* (Mantodea) in Germany under climate change

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Within past decades a considerable range expansion of the thermophilic *Mantis religiosa* was observed in Germany. While *M. religiosa* was so far limited to west Germany, it is now also found in east Germany. We presume that rising mean summer temperatures, resulting from climatic warming, and landscape changes drive this recent range expansion of *M. religiosa*. The proportion of area exceeding the threshold temperature for the occurrence of *M. religiosa* (ca. 14°C) has increased during the last decades in Germany.

To determine the ancestry of German *M. religiosa* we sequenced four mitochondrial genes (COI, COII, Cytb, ND4) of European *M. religiosa* populations. We found an East, Central and West European lineage of *M. religiosa*. Mismatch distributions supported range expansions of the Central and West lineages. Within Germany we found haplotypes clustering to the Central and West lineage. Regressions of haplotype diversity against log geographic distance indicated that east German populations descended from the Central lineage and that west German populations descended from the West lineage.

In conclusion, *M. religiosa* colonized Germany via two major routes connecting thermally favourable geographic regions: West German populations descended from French populations and east German populations most likely descended from Czech populations.

P1 - Flexible strategies of the Azure-winged Magpies (*Cyanopica cyanus* Pallas, 1776) against nest predation in northern Mongolia

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Nest predators of the Azure-winged magpie are varied in populations which are far from each other. The Great spotted cuckoo (*Clamator glandarius*) is common nest predator and nest parasite in Iberian Azure-winged magpie's population, while Jungle Crows (*Corvus macrorhynchos*) are the main nest predator in the Japanese population and Carrion Crows are (*Corvus corone*) in some breeding colonies in the Mongolian population. We studied the relationship between predator and breeding colony of the Azure-winged Magpie and its cooperative breeding system in Khonin Nuga field station in northern Mongolia since 2007. Few studies have been conducted to reveal relation between predation rate and distance between nests of predator to breeding site of prey species. From our study, we discovered several strategies against nest predation by Azure-winged Magpies. A pair of

Carrion Crow breed near the Azure-winged Magpie's breeding colony every year. Based on evidence, the pair of Carrion Crow is proved as a main predator of the Khonin Nuga breeding colony. The breeding success of the Azure-winged Magpie depends strongly on the distance between their nests and Carrion Crow's nest. We also found that Azure-winged Magpie's response against Carrion Crows reflects the breeding colony size of the Azure-winged Magpie. They tend to chase Carrion Crows from their breeding territory if breeding colony size is large, conversely, if it is small, they prefer to hide or be silent during Carrion Crow's penetration in their breeding site, which was truly effective strategy against predation. Azure winged magpies also have developed several other strategies against nest predation, such as nest concealment, nest location on tree, nesting synchronous and close to each other, nesting in sub-groups that provided much faster and effective response against predators and also contribution from helpers that reduced nest predation.

P2 - Next generation invaders with increased genetic diversity?- A case study on Eurasian willows at the Rio Negro, Argentina

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Eurasian willows (*Salix* spec.) have frequently been transferred to the South American continent where in the very beginning they obviously depend mainly on vegetative propagation. However, as soon as they are co-occurring with mating partners either from their own taxa or from interbreeding congeners they may start to build reproductive communities or hybrid swarms, respectively. In other terms they start to "collect" genetic diversity. In the present study, we are analysing individuals of the most dominant *Salix* hybrid complex (*S. babylonica* x *S. alba*/*S. fragilis*) on islands of the Patagonian Rio Negro, Argentina. We collected leaves of 80 individuals on each of three islands with adult forest stands belonging to a first invasion wave of this hybrid at the Rio Negro. Downstream of these islands smaller, newly established islands with *Salix* hybrid recruitment occur which were sampled as well. Using microsatellite markers we investigate whether there is an increase of allelic and clonal diversity from adult cohorts to cohorts of their offspring and whether the only native *Salix* species in the region, *Salix humboldtiana*, is involved in the reproduction and thus hybridization process. Our study contributes to a better understanding of short- term evolutionary processes within invading woody taxa. First results are presented and discussed.

P3 - Genetic variation and phenotypic plasticity in leaf traits related to water balance in *Anthyllis vulneraria* sensu lato

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Global climate change is a major challenge for the survival of many organisms, and especially so for alpine plants, because in the alpine landscape climate change occurs at an even faster pace. Besides migration and evolutionary adaptation, plants potentially have the capacity to deal with and mitigate effects of climate change by adjusting their phenotype in response to environmental change, a common phenomenon called phenotypic plasticity. Most organisms show phenotypic plasticity, but plants are expected to be particularly plastic since they are sessile and cannot avoid adversary conditions by physical relocation. We have subjected alpine populations of *Anthyllis vulneraria* s. l. to two treatments of soil water availability and quantified phenotypic plasticity for a number of leaf traits related to water stress in a maternal half-sib design. Populations originated from two regions in the central Alps with dissimilar precipitation regimes but similar temperatures. Plasticity in response to drought ranged from substantial to negligible depending on the trait. Results of a selection analysis and assessment of costs of plasticity indicate that the observed plasticity is not adaptive, however, and not associated with any costs either. Therefore, we conclude that the potential of alpine *Anthyllis vulneraria* for adaptive plastic responses to climate change is limited. Developmental canalisation may generally be greater in alpine plants compared to lowland species due to the challenging environmental conditions and short growing seasons, and adaptive phenotypic plasticity is probably not an important survival strategy of alpine plants.

P4 - Molecular and quantitative genetic variation in the Central European endemic *Saxifraga rosacea* subsp. *sponhemica*

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The effects of habitat fragmentation on quantitative genetic variation in plant populations are still poorly known. We investigated the variation within and among population of the Central European endemic rock plant *Saxifraga rosacea* subsp. *sponhemica* using both neutral molecular markers (RAPD) and quantitative traits. Seed families from 22 populations from the whole distribution area were grown in a common garden. Q_{ST} -values measuring quantitative genetic differentiation were generally higher than F_{ST} measuring molecular marker differentiation, indicating that not only drift but also directional selection has shaped the genetic structure of

the populations. Population means for many quantitative traits were correlated with environmental gradients suggesting that the variation in these traits was adaptive. The evolvability of traits was negatively correlated with the degree of differentiation among populations (Q_{ST}), suggesting that traits under strong selection show little genetic variation within populations. Performance in the common garden was lower for plants from populations with reduced molecular genetic variation, indicating inbreeding depression due to genetic erosion. The evolutionary potential of populations (mean evolvability) was not related to their size, their performance or their neutral genetic diversity. Our results indicate that molecular genetic studies alone are not sufficient to assess the evolutionary potential of rare plant populations.

P5 - Timing of wild bee emergence

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Synchronized timing is of utmost importance for the maintaining of mutualistic wild bee-plant interactions. The negative impact of desynchronization is expected to be highest for species arising early in the season, when the danger of emergence before potential interaction partners is high. Wild bee emergence is mainly triggered by temperature. Additionally, overwintering temperature might influence bee fitness, if the metabolic rate and the consumption of fat reserves depend on temperature. It is not yet clear how exactly overwintering and spring temperatures trigger bee emergence and influence their fitness level. In our study, we aimed to understand the mechanisms of timing under realistic conditions with natural temperature fluctuations. Therefore we conducted an overwintering experiment in climate chambers and selected temperature regimes that were based on long-term (65 years) daily means and extremes from the regional climate station in Würzburg, Germany. Within each regime, temperatures fluctuated within 24 hours and mean temperatures changed monthly. We left two spring-emerging wild bee species, *O. cornuta* and *O. bicornis*, to hibernate in climate chambers and investigated the resulting fitness levels and hatching dates. This experiment lasted from November 2013 until their emergence in the following spring. Additionally we examined how short periods (30 days) of above average high or low temperatures during winter or spring influence hatching dates and fitness levels. Understanding the mechanisms of timing and the consequences for the fitness of the involved species is critical to understand the synchronization and persistence of mutualistic species interactions in a variable environment, e.g. under future global warming.

P6 - Morphology of oil-collecting Pilosity of Female *Rediviva* Bees (Hymenoptera: Apoidea: Melittidae) reflect Host Plant Use

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One of the most fascinating pollination systems was described from southern Africa, involving oil secreting flowers and their oil collecting bee pollinators of the genus *Rediviva* (Melittidae). Female *Rediviva* bees collect floral oil with their forelegs as larval food from twelve plant genera. Some host plants have floral spurs containing oil and spurs differ in shape and length between species. Several *Rediviva* species have evolved elongate forelegs for collecting the oil in the spurs and in some cases the length of spurs and bee forelegs show co-variation at population-level. The diversity of floral hosts used by *Rediviva* suggests morphological adaptation for oil collecting not only with respect to foreleg length but also regarding the pilosity of foretarsi. Therefore, the oil-collecting hair morphology and pilosity on female foretarsi for all 26 species of the southern African endemic bee genus *Rediviva* was studied and related to host plant use based on about 2700 flower visitation records. Four different types of tarsal pilosity and six principal hair types are identified. Differences in fore tarsal pilosity reflect the availability of floral oil and elaiophore morphology of the principal host flowers. *Rediviva* species with short female forelegs exhibit a greater diversity of tarsal oil-collecting pilosity than long-legged species. This contradicts an earlier hypothesis that the pilosity of species with shorter legs might be less complex than in *Rediviva* with elongate forelegs.

END OF SESSION 16

Session 17 - A decade of Landscape Genetics

CHAIRS: JAN O. ENGLER, HENDRIK EDELHOFF

O1 - An introduction to landscape genetics for functional connectivity research

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Landscape genetics is a relatively young field that amalgamates population genetics, landscape ecology, and spatial statistics. The aim of landscape genetics is to identify environmental influences on gene flow and resulting spatial patterns in neutral and adaptive genetic variation. The number of published landscape genetic studies is growing exponentially, and landscape genetic approaches are increasingly used to address questions in ecology, evolution, and conservation.

Since gene flow includes movement (of individuals, pollen etc.), plus survival, plus successful reproduction, landscape genetic data also has tremendous potential for assessing functional connectivity. However, landscape genetics is highly interdisciplinary, and few ecologists and conservation managers possess the expertise to successfully apply landscape genetic approaches. As a result, the full potential of landscape genetics for functional connectivity research has yet to be realized.

In this presentation, I will introduce the basic concepts, methods, and applications of landscape geneticists to non-geneticists. I will first provide an overview of commonly-used data types and analytical methods, and discuss the advantages and limitations of genetic approaches compared to other approaches used in connectivity research. Then, I will present examples from the published literature and from my own work to illustrate the potential of landscape genetics for functional connectivity research. These examples will include landscape genetic applications for a) quantifying functional population connectivity and how it is influenced by environmental heterogeneity, including habitat fragmentation; b) testing barrier effects of linear landscape features, such as roads; c) evaluating the utility of defragmentation measures, such as highway-crossing-structures, and d) optimizing routes for conservation corridors. Finally, I will present remaining challenges in landscape genetics and highlight the need for interdisciplinary collaborations to fully realize the tremendous potential of the field for connectivity research across trophic levels.

O2 - Implementing movement analyses to estimate landscape resistance and functional connectivity in landscape-genetic research

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Estimating resistance of certain landscape features to dispersal movements of organisms is a crucial part of landscape-genetic research. With the availability of new technologies (e.g. GPS telemetry), movement data is increasingly applied to model the response of animals towards different landscape structures. Specifically, habitat features selected during dispersal or migratory phases provide valuable information for measuring landscape effects on functional connectivity. Therefore, analyzing and segmenting individual movement paths with regard to changes in movement modes can be a valuable tool for understanding behavior-specific habitat selection.

I will present a review of different movement analyses to define dispersal stages within individual movement paths using GPS telemetry data of 23 Red Deer (*Cervus elaphus*) from Northern Germany as a case study. In the next step the determined dispersal path segments were linked to several habitat variables in order to quantify specific dispersal habitat preferences. The resulting habitat models were then employed to develop landscape-resistance models. Based on these resistance models, effective distances between the main distribution areas of Red Deer in Northern Germany were calculated.

Furthermore, genetic distances will be determined with genetic samples of more than 100 Red Deer individuals. A landscape-genetic approach can then be used to correlate the effective distances based on the different dispersal habitat models with the genetic distances. Causal modeling will be applied in order to determine the model best describing the observed genetic structures.

The results underline the effectiveness of path analyses to determine potential dispersal movements and their application for quantifying behavior-specific habitat preferences. Furthermore, the approach provides new insights in species-specific functional connectivity. Therefore, it can also improve management measures to maintain dispersal corridors and gene flow in fragmented landscapes.

O3 - Are roads barriers to gene flow in large mammals?

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A large part of Europe is dominated by human land-use and characterized by artificial structures. In addition to urbanization, agriculture and industry, the development of a dense network of transport infrastructure has been a major driver of fragmentation and loss of habitat connectivity. Continuing development will inevitably lead to the landscape matrix becoming increasingly impermeable for dispersing wildlife, as suitable habitat patches become more widely scattered. Loss of connectivity between disjointed subpopulations can threaten their long-term viability. While it is therefore particularly important that resource managers understand the permeability of their road network for vulnerable species, the effects of roads on the crossing behaviour of different species of wildlife are often not clear and depend on traffic volume as well as the location of over- and underpasses and their structural characteristics. It is therefore often unknown whether roads are permeable enough to prevent genetic isolation of otherwise disjunct populations. There are surprisingly few publications that report the effects of roads on the genetic structure of the larger mammals. Here, I report results from studies using individual-based Bayesian clustering approaches to assess the influence of roads (and rivers) on genetic connectivity in three species of large mammal (badger, wild boar, red deer). Study areas included the UK and Belgium. I will address analytical issues including clustering artefacts caused by isolation-by-distance patterns and the ability of clustering methods to detect recent anthropogenic barriers when working with species that are long-lived, relatively mobile and have large effective population sizes.

O4 - Effects of traffic infrastructure and land-use types on genetic exchange between populations of water frogs in Switzerland

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In human-dominated landscape, traffic infrastructure has been recognized as a major challenge for the migration of wildlife. Highly frequented roads may result in a barrier effect to dispersal and migration, thus reducing genetic exchange between populations. The long-term effects of roads on genetic exchange in relation to other landscape elements are not well understood. Here, we analyse whether different types of traffic infrastructure and other landscape elements represent barriers or corridors for genetic exchange between breeding ponds of water frogs (*Pelophylax* spp.). DNA samples of 999 frogs from 58 ponds were retrieved for nuclear microsatellite analysis. The ponds were distributed along three motorway segments in the densely settled and agriculturally intensely used Swiss lowlands.

Landscape-genetic analyses using partial Mantel and multiple regression on distance matrices revealed significant barrier effects of motorways. Genetic exchange was additionally hindered by the number of main roads between

breeding ponds. The presence of railways did not affect the genetic structure of the water frogs. In turn, a corridor analysis of land-use types indicated that gene flow was increased given high proportions of agricultural land between ponds. Contrarily, gene flow was decreased with water bodies and wetlands between ponds. This seemingly counter-intuitive result may indicate that availability of potential breeding ponds restrict migration distances of individuals, thus likely leading to stepwise colonization.

We conclude that improving connectivity across highly frequented roads will help better linking hitherto separated breeding ponds in water frogs in human-dominated landscapes.

O5 - Sex in the city: hybridization among native and invasive wall lizards

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The common wall lizard (*Podarcis muralis*) is distributed mostly along the rivers Rhine and Mosel in Germany and is often bound to anthropogenic habitats such as dry stone walls or railway lines. In Germany, there are two native evolutionary lineages but, moreover, seven non-native and invasive evolutionary lineages have established here. Introduced mainly accidentally by railway traffic or intentionally by hobbyists, many introductions have occurred within city realms. We sampled four cities in Germany known to have a high density of the common wall lizard, two cities with only native lineages present and two cities inhabited by native and invasive lineages alike. We sequenced a mitochondrial gene (*cytochrome B*) to determine evolutionary origin of individuals and analyzed 17 microsatellite loci to define population membership. Analyzing over 800 individuals in total (ca. 200 per city), we wanted to identify major differences between lineages concerning barriers of dispersal and pathways of gene transfer within cities. Combining sequences with a landscape genetic approach, we detected highly structured populations, and located potential contact zones of still isolated populations. We detected a high degree of hybridization between lizards of different evolutionary origin. The degree of hybridization between native and invasive lineages poses a serious threat to the native lineage and we hope to develop necessary strategies to ensure its persistence, e.g. by developing strategic barriers to stop movement and subsequent hybridization. Conservation efforts towards the common wall lizard need to be accompanied by genetic analysis, as identification of invasive lineages is complicated by a highly polymorphic appearance, not always allowing a clear distinction of lineages prior genetic analysis.

O6 - Predicting dispersal corridors from landscape-mediated gene flow in an endangered capercaillie (*Tetrao urogallus*) metapopulation

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Functional connectivity between spatially disjoint habitat patches is a key factor for the persistence of endangered species in fragmented landscapes. Connectivity models for identifying potential dispersal corridors require information about those landscape features affecting dispersal. We used non-invasively sampled spatial and genetic data of a highly fragmented population of capercaillie (*Tetrao urogallus*) in South-western Germany to investigate landscape-effects on gene flow and to parameterize a spatially explicit corridor model for conservation purposes. Pairwise relatedness between individuals was used as an estimate of gene-flow. Mantel regressions were employed to quantify the effect of different landscape features on relatedness while controlling for geographic distance. We extrapolated the results to an area-wide landscape permeability map and developed a corridor model that incorporates stochasticity in simulating animal movement. The model was evaluated using both data partitioning and independent observation data of dispersing birds. Most land cover variables (coniferous forest, forest edges, agricultural land, roads, settlements) and one topographic variable (topographic exposure) were significantly correlated with gene flow. Whereas isolation by distance was biased towards the philopatric males, no sex-specific differences were detected for landscape structure effects. Although inter-individual relatedness inherently varied greatly and the variance explained by geographic distance and landscape structure was low, the model significantly explained relatedness in the validation data and the spatial distribution of dispersing birds. Effects of landscape structure on gene flow were measurable even within a still interconnected population of a highly mobile bird. By converting these effects into spatial information our model enables localising priority areas for the preservation or restoration of metapopulation connectivity.

O7 - Is genetic differentiation between individuals of *Abax parallelepipedus* driven by resistance, barriers, or distance?

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Habitat fragmentation is one of the major conservation issues facing us today. Fragmentation affects not only species distributions and diversity, but genetic

population structure as well. The forests in Germany are embedded in complex landscapes, and little is known about the relationship between the landscape structure and the genetic structure of individuals inhabiting the forests. The three main processes thought to drive differentiation are isolation by distance, isolation by landscape, and isolation by barriers. We tested the relative effects of these three possibilities in three regions across Germany. We sampled 143 populations of *Abax parallelepipedus*, a stenotopic and flightless forest ground beetle in the forest plots of the Biodiversity Exploratories. We built high resolution resistance and barrier matrices for each region based on the current landscape, and assessed which of these factors appear to be driving genetic differentiation at the individual level. Knowing the drivers of genetic process at landscape level is a crucial step towards better planning and development, allowing us to better maintain viable populations of species across entire regions.

O8 - The persistence of widespread insect species in modern agricultural landscapes

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Agriculture has shaped landscapes over centuries. While this has given rise to a rich variety of semi-natural habitats and many species depending on farming practices, the continuous agricultural intensification has also led to the fragmentation and loss of many of these habitats and their associated species. To hold this loss, identification of vulnerable species and the particular characteristics that make them sensitive towards habitat fragmentation is important especially in light of expected future global change. However, it remains largely unknown to what extent fragmentation will affect also widespread abundant generalist species. Therefore, we chose two closely related bush cricket species to study effects of habitat fragmentation and matrix quality in agricultural landscapes on the species' population genetic structure and their movement patterns. We found a differing threshold to habitat fragmentation between both bush crickets at the landscape scale. While the grassland species exhibited a uniform genetic structuring along the whole fragmentation gradient, the woodland species showed reduced genetic diversity and increased genetic differentiation once the amount of suitable habitat dropped below a threshold of 20 percent and its proximity decreased substantially. By further investigating the woodland species' sensitivity to habitat fragmentation, we revealed that gene flow is restricted in these very highly fragmented landscapes not only at a large but also at a small spatial scale, however with a high matrix

quality lowering negative effects of fragmentation. We conclude that even for widespread species, habitat fragmentation in modern agricultural landscapes may reach a critical threshold below which the long-term survival of these species may become threatened. We further claim that reliable inferences about consequences of habitat fragmentation require attention to species-specific traits and their interactions with environmental conditions at multiple spatial scales.

O9 - Dispersal capability is a major determinant of the genetic population structure of two wetland insects

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Landscape fragmentation due to anthropogenic activities is a major threat to the survival of populations for a wide range of species. Especially wetlands are among the most vulnerable terrestrial habitat types and have become severely fragmented in Central Europe. Therefore, it is important to unravel the degree of isolation of specialized wetland species. We studied the genetic population structure of two wetland insect species differing in dispersal capability, the flightless water-meadow grasshopper (*Chorthippus montanus*) and the much more mobile lesser marbled fritillary (*Brenthis ino*). We sampled 14 populations of *C. montanus* and nine population of *B. ino* in the Hunsrück Mountains (SW Germany) and genotyped them at ten and eleven polymorphic microsatellite loci, respectively. While the populations of the poor disperser, *C. montanus*, were highly fragmented (best $K = 13$ for 14 populations), strong connectivity existed among populations of the mobile butterfly ($K = 2$ for nine populations). Using a novel Bayesian Landscape Genetics approach, we revealed that covered areas and forests provide substantial barriers to gene flow among populations of both species. Our study underlines the importance of improving the habitat connectivity for wetland species via conserving small wetland patches, which may serve as stepping stones hereby creating new corridors for such species. The current habitat connectivity program in the region focuses on forest habitats, and may thus create new barriers to threatened open-land species.

O10 - Assessing landscape mediated gene-flow in three sympatric Hesperid butterflies with diverging ecological traits

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Combining species distribution models (SDMs) with genetic data have revealed several insights in the phylogeographic history of many taxa. More recently, studies also started to incorporate SDMs for the analysis of contemporary gene-flow within a landscape genetic context. In this study, we exemplify this approach in combining SDMs with connectivity models using a comparative genetic set derived from three congeneric Skipper butterflies (Hesperiidae, *Thymelicus*) with diverging ecological traits. To understand how landscape characteristics affect gene-flow in species with diverging ecological traits, it is important to analyze taxonomically related sympatric species in the same landscape using identical methods. We based our inferences on two different analytical methods and two metrics of genetic differentiation. Results indicate that land use patterns influence population connectivity in the least mobile specialist *T. acteon*. In contrast, populations of the highly mobile generalist *T. lineola* were panmictic, lacking any landscape related effect on genetic differentiation. In the species with intermediate ecological traits, *T. sylvestris*, climate has a strong impact on inter-population connectivity. Our results show that closely related species with gradually changing ecological traits also show genetic structures and landscape genetic relationships that gradually change from a geographical macro- to micro-scale. Thus, the type and magnitude of landscape effects on gene-flow can differ strongly even among closely related species inhabiting the same landscape, and depend on their relative degree of specialization. In addition, the use of different genetic differentiation metrics makes it possible to detect recent changes in the relative importance of landscape factors affecting gene-flow, which likely change as a result of contemporary habitat alterations.

END OF SESSION 17

Session 18 - Fungal decomposition

CHAIRS: DEREK PERSOH, JENS WÖLLECKE

O1 - Functional diversity of mycorrhizal and decomposer fungi in vertical soil profiles

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Saprotrophic and mycorrhizal fungi are both found in decaying plant litter. Due to limited saprotrophic capabilities of ectomycorrhizal fungi in particular, nitrogen mobilization from litter by mycorrhizal fungi was hypothesized to depend on the activity of saprotrophic fungi. This relationship, however, is challenged by the results from cultivation-independent high-throughput sequencing of environmental DNA, which indicates a vertical separation of saprotrophic and mycorrhizal fungi in soil profiles. Furthermore, enzyme-assays indicate that mycorrhizal fungi actively degrade structural plant compounds. This contradicting evidence for the functional roles of mycorrhizal and decomposer fungi is discussed against new molecular and experimental evidence.

O2 - How does forest management influence the functional diversity of soil fungal communities?

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Fungi play a significant role in the functioning of soil ecosystems serving as pathogens or more likely as symbionts and saprobes. Changes in the soil fungal community composition has been shown to be influenced by plant community composition at different spatial scales. However, little is understood about the relationship between soil fungi and forest tree species composition, forest management practices or geographical distances between forest sites.

We are currently studying soil fungal communities in three forest ecosystems to fill this gap of knowledge. Our study covers a total of 150 forest experimental plots within three large-scale and long-term research sites across Germany. Those sites were established by a large interdisciplinary consortium funded by the German Science Foundation – DFG called the *German Biodiversity Exploratories*. Furthermore a broad range of management types varying from unmanaged naturally forest to highly managed timberlands complete the design of the study sites. We assessed the soil fungal community structures and diversity in each of the

150 forest plots using high-throughput amplicon pyrosequencing, targeting the ITS region of the fungal rDNA as marker.

We hypothesize that the fungal communities are affected by various biotic and abiotic factors, such as management types and soil characteristics. We expect to see a dominance of ectomycorrhizal communities in monospecific forests with recalcitrant litter (e.g. spruce). However, we assume that with an increase in tree diversity and tree age heterogeneity a shift of the fungal community composition from mycorrhizal towards more saprotrophic or decomposer fungal communities will occur.

O3 - Wood-inhabiting fungal communities with respect to substrate preferences and the surrounding environment

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Decaying dead wood is an energy source and habitat for a wide range of organisms. Wood-inhabiting fungi play a key role in wood decomposition. Many of these fungi, especially the polypores, are well documented and their preferences to certain tree species are generally known. Nevertheless, the influence of different environmental factors and forest management intensity on the diversity and composition of fungal communities is poorly studied. Based on an experimental design our study aims to analyze these relationships.

The dead wood experiment (BeLongDead), a core project within the Biodiversity Exploratories, is being conducted at 30 forest plots in three regions of Germany under different forest management regimes. We record occurrence and abundance data of fungal sporocarps on 1140 logs comprising 13 different tree species (9 deciduous, 4 coniferous). Contrary to molecular methods, sporocarp inventories ensure exclusively species with wood decay activity. Our inventory combines two complementary methods – an overview and a detailed approach – which differ in the range of surveyed fungal species. To determine the fungal community-level patterns of substrate preferences we apply a cluster analysis. In a next step we will quantify preferences of different fungal communities in respect to wood properties and the surrounding environment.

The cluster analysis shows a clear distinction of angiosperm and gymnosperm wood-inhabiting fungal communities. About 50% of the species occur only on angiosperm and only 10% almost exclusively on gymnosperm wood. Within the angiosperms *Carpinus*, *Betula*, and *Fagus* are the most fungus-rich substrates.

Analyses of data are still in progress, but field observations and preliminary results suggest a remarkable influence of management regimes on fungal substrate spectra and community composition. Although fungi are known as long-distance dispersed organisms the local stand diversity affects the fungal diversity on the different substrates.

O4 - Microbial life on dead leaves - a metaproteomics approach to unravel the major microbial players in litter decomposition

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Leaf-litter decomposition is the physical and chemical breakdown of plant material, a key ecosystem process that is strongly influenced by microorganisms. Litter quality influences the structure and function of the decomposer communities, as these likely differ in their C substrate preferences and may also differ in their responses to N and P availability. Seasonal and site specific differences in litter quality may therefore alter species composition and elicit changes microbial community activities. Metaproteomics allows us to link the abundance and activity of enzymes during nutrient cycling with their phylogenetic origin based on proteins.

We employed a metaproteomics approach to investigate the influence of nutrient conditions on the decomposer structure and function during beech litter decomposition. Beech leaf litter was collected in winter and spring at four forest sites in Austria with different litter nutrient concentrations. Proteins were analysed by 1-D-SDS-PAGE followed by liquid-chromatography and tandem mass-spectrometry (LC-MS/MS). Mass spectra were assigned to phylogenetic and functional groups by a newly developed bioinformatics workflow and assignments validated by complementary approaches.

Results showed that fungi play a central role as producers of degrading enzymes while bacteria seem to benefit from the presence of fungal enzymes. Cellulase production was observed as an important factor for decomposition; it seems to be mainly site-dependent and drives the succession of the decomposer community. Microbial succession was induced by litter nutrients via the presence and activity of extracellular enzymes. Our data suggest that exudation of polymer degrading enzymes is limiting litter decomposition and it is regulated by microbial demands.

O5 - Drought impact on trees - effects on ectomycorrhizal community functions

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Drought has become one of the most important abiotic stresses under the light of climate change especially for long-living forest trees. Trees exposed to such conditions might take advantage from ectomycorrhizae by increasing access to soil water and nutrients from finer soil pores than roots. Our focus in this study about drought as a modifier of interactions between beech and spruce is on belowground relations between tree roots and ectomycorrhizal fungi. Based on a controlled throughfall exclusion experiment (Kranzberg roof experiment (KROOF)) we study the long-term drought impact on ectomycorrhizal community composition and functions in pure and mixed stands of Norway spruce and European beech.

Our particular interest is to clarify the influence of the tree host, its competitive situation in a stand, and the magnitude of changes under imposed drought on ectomycorrhizal structural and functional diversity. The two tree species with different survival strategies will alter carbon allocation to the root system and is hypothesized to influence ECM functional traits. In a first step, a thorough characterization of the ECM distribution, diversity and community composition in the designated control and treatment plots showed a comparable diversity in all plots and as expected different ECM communities associated with spruce and beech prior to the start of the experiment. In addition, patterns of functional traits of ECM communities which might be relevant for drought tolerance (exploration types, hydrophobicity, extracellular enzymes) were also analyzed.

Hypotheses, concepts as well as first results are presented and discussed which are unique in terms of the intra versus inter-specific assessment of reactions on trees in their belowground systems.

O6 - Spatial interactions between mycorrhizal and decomposer fungi in soil

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The spatial distribution of many saprotrophic fungi depends on the presence of specific substrates, even within different soil layers. For other species the decomposition stage of the organic material, characteristic for a given soil layer, seems to define their preferred habitat. Especially in forest soils mycorrhizal fungi colonizing the organic matter and for most of them their distribution is restricted to specific soil horizons and or organic layers. The question, in which way mycorrhizal and saprotrophic fungi interact with each other, determines the distribution pattern of both fungal groups. On one hand they compete with each other for nutrients and water. On the other hand it is hypothesized, that the mycorrhizal fungi depend on the decomposition activity of saprotrophic fungi to a certain degree. Mapping the distribution of both fungal groups on a micro scale could give first insights in the competition and interdependency of species sharing the same micro habitats.

END OF SESSION 18

Session 19 - Microbial primary producers

CHAIRS: BASTIAN STEUDEL, MAIKE LORENZ

O1 - Soils in Central Europe veil novel lineages of eukaryotic microalgae and species with close relatives from tropics and polar regions

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The soil biodiversity of protists and in particular eukaryotic microalgae is still considered to be largely unveiled. Our investigations suggest that detailed surveys on the molecular biodiversity in soils even in Central Europe yield a considerable number of undescribed and unknown taxa. Terrestrial microalgae are morphologically very simple and only a handful of distinguishable morphotypes were repeatedly observed in soils from different regions or climatic zones. Therefore, our knowledge about the biogeography of the soil microalgae still remains poor. SSU and ITS2 rDNA sequencing of 160 isolates of soil microalgae revealed some lineages new for Central Europe and provided the first molecular evidence for the wide distribution of several ITS2-ribotypes. For example, the Trebouxiophyceae *Chlorella* and *Stichococcus* with rather simple coccal and rod-shaped morphologies were found to be phylogenetically considerably diverse. The vast majority of their molecular diversity includes rare ribotypes recorded from only a single sampling site. On the other hand, the long expected finding of ribotypes with a distribution over two different continents became more frequent, possibly solving the still ongoing debate about the dispersal of some soil microorganisms.

O2 - Controls of biological nitrogen fixation during ecosystem development

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After catastrophic disturbances soil nitrogen is depleted from soils however phosphorus may be highly available in P rich minerals. A key process incorporating new nitrogen to ecosystems is biological N fixation (BNF), which is favored under N depletion and P abundance. Therefore the recovery of ecosystems is completely dependent on the performance by diazotrophic bacteria of this key ecosystem

function. The main objective of this work was to explore which are the main chemical elements that limit BNF during ecosystem development in both a long term post-volcanic chronosequence and a short term postglacial chronosequence in Chile. We selected three developmental stages in each one of both; a post-volcanic chronosequence located in south-central Chile and a post glacial chronosequence located in glacial forelands of Cordillera de Darwin. BNF was assessed by measuring the acetylene reduction activity (ARA) under different nutrient additions of Mo, P, C, (alone and in combination) and N in litter and cryptogamic carpets covering the soils and as epiphytes, in samples taken during autumn, winter and spring in the post volcanic chronosequence and during spring 2013 in the glacier foreland chronosequence.

Results show that in the long term post volcanic chronosequence molybdenum addition significantly increased ARA in litter during the maximum and retrogressive phase in almost all seasons, and during autumn in *Racomitrium* carpets of the early phase. N addition significantly inhibited ARA in almost all season and phases in the litter and cryptogamic flora. In the short term glacier foreland chronosequence the addition of Mo, P and C separately increased ARA in the litter layer of the intermediate phase and only the addition of the three elements together increased ARA in both the litter and cryptogamic flora during the late phase.

Our main conclusion is that the type of nutrient limitation to BNF is highly dependent on the phase of ecosystem development.

O3 - Changes in Antarctic soil microalgal communities along a gradient of soil developmental stages and testing for geographical distribution of soil algae

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Antarctic soils are ideal places to study particular features of soil microalgae and cyanobacteria left unexplored so far. These include inferring pioneer species at the colonization of young soils poor in nutrients and the development of soil microalgal communities almost without anthropogenic influence and that of vascular plant cover under harsh environmental conditions. In our project glacier forefields at Maritime Antarctica are studied for the succession of their microalgal communities using mainly culture-independent methods, i.e. analyses of highly variable molecular signatures. Correlations of changes in algal/cyanobacteria soil communities with various developmental stages of soil are tested to allow inferring possible functional/ecophysiological traits of Antarctic soil algae. We also investigate whether the geographical remoteness of Antarctica and its particular harsh environmental conditions allow for the development of particularly adapted Antarctic soil algal populations distinct at the genotypic level from their

counterparts of temperate regions. Analyses of cultured isolates of Xanthophyceae (Stramenopiles) indicated a genotypic distinctness of Antarctic algal populations. However, culture-independent analyses of Klebsormidiophyceae (Streptophyta, Green Algae) challenged this view as their ITS2 rDNA sequences were fully identical with corresponding sequences from their temperate counterparts. This may be explained by the fact that Klebsormidiophyceae are more drought-tolerant than Xanthophyceae thus facilitating their distribution around the globe.

O4 - Microalgae as model in ecosystem-functioning experiments

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Microalgae show similar effects of biodiversity like vascular plants. However, they grow faster and need less space than higher plants. Thus, they represent good model organisms to conduct experiments with high numbers of replicates. I will present some new results of experimental approaches conducted with 64 microalgae, including other measurements of biodiversity than species richness, i.e., phylogenetic and functional diversity. We were able to show that high levels of phylogenetic diversity at species rich assemblages leads to a decline of ecosystem functioning, while increasing functional diversity shows the expected increase of biomass production. This is an additional evidence that phylogenetic diversity is not a suitable proxy of functional diversity and may thus not be used to extrapolate expected ecosystem functioning and stability.

P1 - Biodiversity of terrestrial green algae in a tropical mountain rain forest of Ecuador (Podocarpus National Park)

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The tropical rain forests in Ecuador are one of the species biodiversity hotspots of the world. Here we present the first culture-dependent investigation of terrestrial microalgae in South Ecuador, i.e. the Podocarpus National Park. Soil, leaf and tree bark samples were collected at three different elevations, i.e. 1000 m a.s.l. (Bombuscaro), 2000 m a.s.l. (San Francisco) and 3000 m a.s.l. (Cajanuma) and enrichment as well as unialgal cultures were established. Microscopic observations revealed 17 morphotypes of Chlorophyceae, Trebouxiophyceae and Klebsormidiophyceae. From enrichment cultures rRNA gene clone libraries, comprising the 3'-end of 18S and complete ITS2 rRNA, were established. Phylogenetic analyses of the sequences revealed 68 phylotypes which may correspond to 19 genera of Green algae with most phylotypes from the

Trebouxiophyceae *Coccomyxa*, *Elliptochloris*, *Auxenochlorella* and *Stichococcus*. Comparison with results from a culture-independent approach (which was performed in another parallel study) showed only very few phylotypes, which corresponded to those from the culture-dependent approach. Therefore, only the combination of both approaches may accomplish comprehensive assessment of the algal biodiversity.

END OF SESSION 19

Session 20 - Spatial patterns and ecological processes

CHAIRS: KATRIN MEYER, DANIEL ESSER

O1 - Negative Feedback as Driver of Spatio-Temporal Patterns in Plants: A Unified Multiscale Model

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Characteristic spatio-temporal patterns linked with dispersal processes have been observed at varying scales in plants. These range from dispersal kernels visible at the individual level to patterns emerging through interactions between plants at the population or community level. Generally, each pattern has been studied separately and has given rise to a specific set of potential explicative theories.

We focus our demonstration on three patterns reported in plants at different scales. (i) At the individual scale, the Janzen-Connell hypothesis, which is one popular explanation for the maintenance of tree biodiversity in tropical environments, relies on a characteristic seedling recruitment curve that is believed to stem from host-specific predation. (ii) At the population scale, several types of vegetation patterns (e.g. stripes, labyrinths, spots) have been observed, especially in arid regions, and have been hypothesized to originate from either individual-scale intraspecific interactions or water limitations. Among these, rings and so-called “fairy circles” have been the most challenging to explain. (iii) At community level, small-scale species turnover have been observed to produce counter-intuitive temporal variations in species richness (i.e. stable scale-independent species diversity, but cumulative values increasing in time at every scale). This has been assumed to come from species mobility and niche exploitation.

Here, we show that these phenomena can be rendered under a unique theory relying on the concept of species-specific negative-feedback. We present a simple hybrid model coupling an Individual-Based approach, in which each plant is recognized as a separate entity, with a spatial System Dynamics submodel rendering accumulation of autotoxic compounds in the soil. Through spatially-explicit simulations, we expose how this model is able to reproduce the three behaviours mentioned previously.

O2 - Patterns of ground vegetation and their dependence on environmental factors in three forest types of Bolivia - a case study

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In order to protect biodiversity and important ecological system services of tropical forests on a long-term perspective, expert-based concepts for nature conservation are necessary. Many fundamental studies about the spatial distribution of plant species in tropical forests, that discuss biotic and abiotic environmental factors, are focusing on trees. The terrestrial herbs in these forest ecosystems and their habitat conditions have received much less attention, although they are an important part of the ecosystems. Therefore, the presented study investigates the ground vegetation in three 1-ha sized plots of different forest types (evergreen, semi-deciduous and deciduous) in Central Bolivia and their dependence on environmental factors. Parameters of vegetation assessment and soil analysis were the basis for a geoinformatic-statistical modelling process. Using the plant group monocotyledons and the plant species *Commelina erecta* as an example the modelling process will be shown. Methods of exploratory regression, model selection and the analysis of spatial autocorrelation were used to analyse the vegetation patterns of the herbs. As the result different models for the plant group monocotyledons and the species *Commelina erecta* will be discussed. Ecological knowledge as well as statistical methods were taken into consideration for the modelling process.

O3 - Ecological studies of long-term historical constraints on functional diversity of palms (Arecaceae) across the Neotropics

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This project concerns geographic patterns in palm functional diversity (FD) and its underlying drivers. A key focus was on testing the new hypothesis that ecosystem functioning is subject to long-term (10^4 - 10^5 years) historical constraints, mediated by effects of past climate change and other historical factors on functional diversity. FD can be defined as the mean value, range and relative abundance of plant functional traits in a given biotic assemblage. In our study, we focused on the palms (*Arecaceae*), a pantropical, ecologically important plant lineage with approximately more than 2600 species and considered of key-stone importance in tropical and subtropical ecosystems. Geographic patterns of functional trait

distributions in general have in some cases been found to be strongly correlated with environmental variables like current temperature and precipitation, while little attention has been given to potential historical drivers. In our study we focused on three single palm functional traits as response variables, namely leaf size, stem height and fruit volume which showed various geographic distribution patterns. Leaf size showed its highest values around the Amazon Basin while fruit size in the Guiana Shield and stem height near the drier coasts. We detected that palm functional trait distributions are jointly controlled by present and past environment and unknown spatial processes. Notably, both current climate and Quaternary glacial-interglacial temperature change have relatively strong effects on functional trait patterns, mainly for palm leaf size and fruit volume. Hence, our study demonstrates that beside current environmental also historical factors can drive functional trait patterns on a macroecological scale.

O4 - Metapopulation and metacommunity processes

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The aim of my study was to increase the knowledge about metapopulation and metacommunity processes in patchy, dynamic landscapes, using epiphytic bryophytes as a model system. Host trees and deciduous forest stands in the coniferous landscape of Sweden are patchy, temporal and undergo changes in habitat quality during succession. Epiphytes must track this dynamic habitat network for their long-term survival. Community patterns at different spatial scales were explored and linked to regional metapopulation processes and local population dynamics.

Spatial structuring in species richness both at a local and regional scale indicated stronger dispersal limitation, but lower sensitivity to habitat quality in species with large asexual than in species with small sexual diaspores. Present connectivity to other deciduous forest patches had positive effects on richness of asexually dispersed species, whereas richness of sexually dispersed species was instead related to the landscape 30 years ago. A study of local growth and reproduction suggested that this is caused by delayed sexual, but not asexual, reproduction. Habitat conditions affected the production of sporophytes, but not of asexual diaspores. In vitro experiments showed that establishment is higher from large asexual diaspores than from small sexual.

The results indicate that the epiphyte metacommunity is structured by two main trade-offs: dispersal distance versus age at first reproduction, and dispersal distance versus sensitivity to habitat quality. Trade-offs in species traits may have evolved as a consequence of conflicting selection pressures imposed by habitat turnover, patchiness, and quality. Increasing distances among patches may cause most harm to asexually dispersed species, whereas cuttings of forests of high age

and quality as well as increasing patch dynamics may be most harmful to sexuallydispersed species.

O5 - Is there still an extinction debt in temperate forest herbs in NE-Germany after massive historical habitat fragmentation?

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In many ecosystems, we find a time-delayed loss of species after habitat fragmentation. The magnitude and relaxation time of this 'Extinction debt' depends on the specific ecosystem, species group and extent of fragmentation. The detection of an extinction debt can be challenging because comprehensive data of the landscape history and/or historical species distributions are needed.

We used historical maps that ranged back to ca. 1780 to reconstruct the deciduous forest distribution of the Prignitz region (NW Brandenburg, Germany). We found a forest area loss of more than 94% in combination with a substantial loss of forest connectivity since 1780. The vast majority of the deciduous forest area vanished until 1880 leading to a highly fragmented forest landscape since.

We surveyed the herb species richness of 104 forest patches and fitted species richness as a function of historical (1780) and recent (2013) forest area and connectivity along with additional patch quality and patch heterogeneity variables. The results showed an effect of historical forest connectivity on recent forest specialist species richness. In particular, there was a relationship of historical connectivity with richness of specialists with high seed mass and short-distance dispersal. However, models with recent patch area and connectivity were always the overall better models in explaining current species richness. This leads to the conclusion that the extinction debt has largely been paid after 150-200 years of relaxation time.

O6 - Colonization credit in post-agricultural forest herb-layer communities remains more than 130 years after reforestation

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In many temperate regions of the world, a large portion of broadleaved forest grows on former agricultural land, while "ancient" forests with no historical record of agricultural land use constitute only a small fraction. The recovery of the herbaceous plant community in post-agricultural forests was object of much research during the last decades, and differences in species composition and diversity between ancient and post-agricultural forests are well documented.

However, in regions, where forest fragmentation occurred not more than a few centuries ago, it remains unclear whether the difference in species richness is due to an extinction debt in ancient forests (i.e., a delay in local species extinction) or a colonization credit in post-agricultural forests (i.e., some species are yet to colonize a patch) or both. Also, our knowledge on how habitat quality (e.g. soil conditions) and landscape configuration (e.g. forest patch connectivity) interact with species life-history traits to modify the magnitude of the colonization credit is limited. In this study, we used a comprehensive sample of ancient and post-agricultural forest patches in the Prignitz region (NW Brandenburg, Germany) to quantify the magnitude of the colonization credit and identify its determinants. For forest specialists, the colonization credit in an average forest patch amounted to 4.7 species and could increase up to 11 species in strongly isolated patches with high soil moisture. Patch age had no significant effect. Species with low dispersal potential, low fecundity and extensive clonal growth contributed most to the colonization credit. The number of habitat generalists tended to be higher than expected in post-agricultural forests, reflecting the low competition by forest specialists. Our study shows that in a landscape where the extinction debt has already been paid, the recovery of forest specialist diversity in post-agricultural forests will take several centuries.

O7 - Multi-taxa assessment of impacts of urban sprawl on species richness: more than built-up area matters!

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Urban sprawl is a major factor of global environmental change and has important impacts on biodiversity like changes in species composition and biotic homogenization. Most studies so far have focused on the effects of urban area, as a general measure of urbanization, and on single or few taxa. We will present a comprehensive analysis of the impacts of urban sprawl on biodiversity in the Swiss Plateau, the largest biogeographic region of Switzerland that has undergone a substantial growth of urban areas in recent decades. We analyse the effects of different components of urban sprawl on a wide range of taxonomic groups (mosses, vascular plants, gastropods, butterflies and birds) that are regularly covered in Swiss biodiversity monitoring programmes at varying spatial scales. We evaluate urban effects on the species richness of each taxonomic group, and of distinct *ecological groups* defined according to species-specific characteristics that are expected to be sensitive to urban development (e.g., dispersal ability and habitat specialization). In addition, we use a broad set of urban predictors, such as urban area, age of development, degree of imperviousness, dispersion, and human population density, in order to disentangle the impacts of the different components of urban sprawl, which up to date have been hardly explored. In

particular, we address the following research questions: (1) which groups of organisms are affected most by urban sprawl, (2) at which spatial scale, (3) which benefit from this process (winners) and which not (losers), and (4) which components of urban sprawl have the strongest impacts. By answering these questions we aim to contribute to a better understanding of biodiversity changes driven by urban sprawl and to generate guidelines for biodiversity conservation under urban development.

O8 - Spatial diversity in Mediterranean river catchments: a multi taxa approach

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Although the important contribution of β -diversity to regional (γ) diversity is increasingly recognised, our understanding of how spatial diversity patterns differ among different taxonomic groups is still limited, especially in dynamic lotic ecosystems.

In this study I assessed the difference in the partitioning of diversity at nested spatial scales, from reaches to catchments, among riparian birds, fish and benthic macroinvertebrates in Mediterranean river systems.

Fish and macroinvertebrates showed similar diversity patterns, with β -diversity always larger than expected by a random distribution of individuals at all spatial scales (among reaches, rivers and catchments), and local (α) diversity always lower than expected. Conversely, β -diversity of riparian birds appeared larger than expected only at the largest scale (among catchments), while local diversity did not differ from random expectation. For birds, however, results partly depended on the weighting of abundant and rare species. Additionally, for all taxa, β -diversity was mostly determined by species turnover rather than by richness differences.

This study is among the first to investigate spatially explicit diversity patterns across taxonomic groups with different ecology and dispersal ability. Results highlighted the substantial contribution of β -diversity to the regional diversity of these Mediterranean catchments, but also showed that functionally different groups exhibit distinct spatial patterns that are consistent with their ecology and dispersal ability.

From a conservation perspective, the results suggest that fish and macroinvertebrate diversity would be enhanced by preserving habitat heterogeneity at both local and large scales, whereas riparian bird diversity would be maximised by protecting multiple catchments.

O9 - Aphid infestation affecting the nutrient dynamics of European beech saplings

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Mass outbreaks of herbivore insects are known to perturb the functional properties of forests, as they substantially alter the biogeochemistry and productivity of infested trees. However, it is less clear how endemic to moderate above-ground herbivory affects the vertical flow of nutrients from tree canopies to the soil.

Here, we report on the effects of low to moderate infestation levels of the woolly beech aphid (*Phyllaphis fagi* L.) on the nutrient dynamics of European beech (*Fagus sylvatica* L.). In a potted sapling experiment we followed the vertical dynamics of macro and micro nutrients via throughfall (TF), stemflow (SF) and litter leachates (LL) collected over ten weeks underneath infested and un-infested control trees. In particular, we sought to identify sources of variability in nutrient concentrations and fluxes associated with infested and un-infested trees by linking the abundance of aphids.

Preliminary results exhibit increased concentrations of K⁺ and particulate nitrogen (0.45 μm < PN < 500 μm) in throughfall solution under aphid infestation, corresponding to intensified fluxes of 6% for K⁺ and 22% for PN relative to the control. Contrarily, ammonium-N (NH₄-N) and dissolved nitrogen (DN) concentrations diminished in co-occurrence of peaking aphid abundance, exhibiting reduced fluxes of 28 and 9%, respectively, compared to the control. Differences in canopy-derived dissolved organic nitrogen (DON) and carbon (DOC), sulfur, Ca²⁺, Mg²⁺, Na⁺, SO₄-S, PO₄-P and NO₃-N were less pronounced. The effect of aphid abundance on nutrient dynamics was most notable in the canopy and diminished in stemflow and litter leachates. However, nutrient concentrations increased in the order TF < SF < LL, creating “hot spots” of DOC and nutrient inputs especially around the trunk area of the saplings.

Imaging of leaf surfaces by scanning electron microscopy (SEM) exhibited notable differences of the surface morphology and microbiology of control, lightly infested, and heavily infested leaves. This observation might point to an aphid-mediated alteration of the phyllosphere ecology triggering the microbial uptake of NH₄-N (DN) and its (trans-)formation to particulate N by magnified biomass growth of the phyllosphere micro-flora, consequently changing the chemical partitioning and temporal availability of nitrogen.

O10 - Stoichiometric homeostasis: Does it hold when exposed to elevated metal concentrations?

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Morphology, often described as visible traits, has played an important role in our understanding of biodiversity. Rather than physical characteristics, an organism's chemical composition was recently proposed as a useful measure. An advantage of the elemental body composition is that it can be measured universally in all species. In this study we used the elemental body composition of 11 elements to investigate differences between macro invertebrate species originating from sites differing in type and level of metal pollution. In this study our main question was whether the elemental body composition is dependent on the species or the environmental concentrations of elements.

To answer this question we used pitfall traps to collect litter dwelling macro invertebrates at two metal pollution (one Zn, one Cu) transects with three sites differing in pollution level. All trapped individuals were identified to the lowest possible taxonomical level and concentrations of 11 elements were measured in individuals, or a group of individuals from a single species. For comparison ten taxa were selected, five detritivorous and five predacious. Using the elemental body composition data, we performed PCA and samples were either grouped by species or site.

The overall results show that particular species are visually separated from others by their elemental body composition. Further, a clear taxonomical response was visible as different Coleoptera species grouped closer together than any coleopteran with species from other taxonomic group. The same pattern was observed for Arachnida. At the same time within species, specimens from different sites were clustered. However no uniform pattern for the clustering of sites was found for all species.

Based on these results we conclude that macro invertebrates do have rather strict within species elemental composition distinguishing them from other species, however some flexibility is observed as sites form clusters within species.

O11 - Population density and spatial distribution of woodland inhabiting ground beetles (Coleoptera: Carabidae) - insights from a mark-recapture study

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The density and spatial distribution of individuals within populations are some of the most important species-related parameters in modern ecology, population biology and conservation biology. Environmental changes can cause changes both in population density and in the spatial distribution of the species and these parameters are important for the understanding of energy fluxes, extinction probabilities and gene flow. To shed light on these patterns we used approximately 500 live pitfall traps in four different forest habitats in the Lüneburger Heide nature reserve to determine both the population density and the spatial distribution of several stenotopic woodland ground beetles.

Despite its scientific importance, population densities of larger terrestrial arthropods like large ground beetles are rarely determined as labor-intensive mark-recapture procedures are needed. In most studies, the authors use catching rates as a surrogate for population density estimates which can then be used to study the spatial distributions. Although population density and catching rates can be well correlated, the latter can also be influenced by environmental parameters which are theoretically independent from the population density. As this relationship is only rarely been studied, we tested if population density and catching rates are related to examine the validity of this commonly used proxy. Likewise the spatial distributions of stenotopic ground beetle species are not well known. The results are discussed – also in the light of the limited information from the literature.

P1 - How landscape structure determines species frequencies - insights from a model

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We investigated the influence of landscape composition and structure on the frequency of species in different artificial agricultural landscapes. For this study, we developed a spatially-explicit metapopulation model with 21 artificial ground-beetle species (Coleoptera).

The species mainly differ in habitat specificity, dispersal ability and persistence of local subpopulations. The parameterization of the model is based on field data and

expert knowledge. Results of the simulation experiments support the following hypothesis: (1) Habitat arrangement has a high influence on the frequency of less mobile species. (2) Highly mobile species' frequencies are determined by landscape composition, only.

Land-use changes accompanied with habitat loss and fragmentation can therefore impact less mobile species merely due to changes in spatial habitat arrangement.

P2 - Trophic differentiation in terrestrial macro invertebrate food web stoichiometry: Does metal pollution play a role?

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Ever since the work of Lindeman in 1942, the flow of energy within food webs has been an important aspect of ecology. The field combining the flux of carbon, representing energy and matter, and other elements in ecosystems is ecological stoichiometry. Using the idea of elemental transfer we aimed at observing differences in elemental stoichiometry between trophic groups (detritivores, mixed predators, specialized predators) of soil macro invertebrates and litter. Further we tried to examine whether the food web stoichiometry would be altered by metal pollution.

For this we selected two metal pollution transects in Poland, one zinc polluted and one copper polluted, and established 3 sites differing in level of pollution at each transect. At the six sites we collected soil macro invertebrates (using pitfall traps) and litter from the forest floor. Collected invertebrates were sorted to the lowest possible taxonomical level. The 23 most common species, belonging to three trophic groups, and occurring at four sites or more were analyzed for 11 elements. Ratios of C to elements were calculated and differences in ecological stoichiometry of the trophic groups were visualized using PCA and differences between trophic groups were tested on PCA axis scores.

Our results show that litter forms a separate group, characterized by a high C:N ratio that is decreasing with trophic level. The three trophic groups were generally placed in a similar way on the PCA graphs for all sites. Detritivores were characterized by high C:Zn ratios, whilst mixed predators had a lower C:Zn ratios - indicating higher body Zn concentrations in mixed predators. Specialized predators, often active hunters, had low C:N and C:P ratios. Only the intermediate Cu polluted site did not show grouping, nevertheless we could conclude that body stoichiometry of soil invertebrates is well preserved within trophic groups.

P3 - Vascular plant diversity patterns in high conservation value forests in lowlands of the Czech Republic

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Diversity of vascular plant species in lowland forests has been formed by natural conditions as well as by long-term human management. Under the recent environmental changes, this diversity changes rapidly. It is therefore essential to analyze diversity patterns and underlying factors in conservation-valued forested sites and landscapes. We did it for major lowland forest areas of the Czech Republic. They are composed mainly of deciduous tree species including oak, lime, hornbeam, maples, elms, ash and beech. Each of the areas is protected under at least one conservation scheme at national and EU-levels. Data on vascular species composition, soil chemistry and canopy properties were collected in 2008-2014 using standardized plots sized 225 m². These plots are designed for a long-term monitoring of ecosystem development under various conservation regimes, but also provide a representative baseline dataset on vascular plant diversity and local abiotic conditions of the Czech lowland forests. Altogether, 600 plots from eight areas were analyzed. Large differences were observed in local (plot-level) and regional (area-level) diversity, and in heterogeneity within sites (between plots). The richest plots had nearly a hundred species. Local conditions represented by soil pH, N, P and other elements, and by canopy openness could not fully explain observed diversity patterns. Considerable regional differences could be due to various land use history, which affected local species pools probably via historical availability of forest environment. Nature conservation policy should design management actions leading to diversification of within-site conditions, but also conspicuous regional differences, to fully understand the value of lowland forest ecosystems.

END OF SESSION 20

Session 21 - Adaptive forest management

CHAIR: CHRISTIAN AMMER

O1 - The role of herbaceous vegetation in forest landscape dynamics: a modelling approach

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Herbaceous understorey vegetation (i.e. grass, ferns, forbs and herbs) can play an important role in the functioning of forest ecosystems, by altering microenvironment conditions on the forest floor and competing with trees for light and soil water resources. In natural and managed forests, dense understorey layers can reduce tree establishment and delay, shift or even halt tree succession.

Forest gap models provide an important tool to assess species interactions and forest dynamics, particularly under changing climate, disturbance and management regimes. These models typically do not include an herbaceous understorey layer, although a growing number of empirical studies emphasize its importance for tree establishment and growth.

We used the forest landscape model LandClim to assess the long-term effects of the interactions between trees and the herbaceous layer, and to explicitly consider the impact of large-scale disturbances in a landscape context.

Simulation results show a strong effect of the herbaceous layer on forest dynamics. The presence of herbaceous vegetation can *delay* tree establishment by up to 50 years, depending on environmental conditions. In addition, the presence of an understorey can induce a *shift* in tree species composition, favoring more shade-tolerant species at the expense of early successional, light-demanding species. No evidence for *halting* succession was found. The level of the impact on tree succession and species composition depends on terrain-specific aspects (i.e., elevation, aspect and slope), emphasizing the importance of considering large spatio-temporal scales when investigating understorey-overstorey interactions.

O2 - Assessing the risk for European spruce bark beetle infestations in Switzerland - from science to practice

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The European spruce bark beetle *Ips typographus* is the most significant insect pest in European spruce forests. The predisposition of a forest stand for bark beetle infestations depends on a multitude of different biotic and abiotic drivers including stand characteristics (e.g. age, species composition), climate factors (e.g.

temperature, precipitation) and disturbances (e.g. windthrows). These factors influence several ecological interactions between the bark beetles and the spruce (*Picea abies*) host and may be altered due to management and climate change.

To investigate the effect of different climatic drivers we developed dynamic models that estimate the beetles' relative population density in different developmental stages, flight periods and number of generations as well as the drought stress of spruce hosts. Furthermore, we combined these dynamic with static modelling approaches to assess the overall predisposition of forest stands against spruce bark beetle infestation.

In this study we investigate different drivers affecting the potential infestation risk on a national scale for Switzerland. We illustrate the bark beetle phenology and the predisposition of forest stands under current environmental conditions and how this is likely to alter under climate change scenarios. This approach allows the identification of regions with increased infestation risk, e.g. due to faster beetle development or increased drought stress of the host tree. Moreover, we demonstrate how our results can be made available to the practice as an online tool.

The information provided by both the model and the online tool might then be taken into account by stakeholders and practitioners for adapting short- and long-term management strategies. Altogether, this study demonstrates how models can be used to evaluate environmental risks and how scientific knowledge can be transferred to practice for supporting the ecological risk assessment in forests.

O3 - Plant-herbivore interaction networks are less susceptible to climate change in fragmented forest habitats

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Habitat fragmentation and climate change are the strongest man-made threats to ecosystems, but how they affect plant herbivore interaction networks is largely unknown, despite their paramount position in the trophic pyramid and their manifold ecosystem functions and services. We studied the robustness of such networks (overall ca. 700 individual interactions) from the North Palatinate highlands, SW Germany, against climate change in fragmentation-affected habitats (forest fragments and forest edges) and continuous control forests by quantifying topological network parameters associated with robustness (complexity, nestedness and niche redundancy) and by modeling climate change-based extinction scenarios.

Fragmentation-affected habitats, particularly forest edges, were coined by networks of higher complexity (Shannon diversity of interactions) and nestedness (BINMATNEST-algorithm) and lesser trophic complementarity (H_2'), thus indicating higher stability. Consequently, modeled extinction cascades (derived from climate change based extinction scenarios) showed networks in forest fragments and edges to be more robust, whereas networks in the forest interior declined more rapidly.

We explain our results via the (i) floristic composition of forest habitats and (ii) the corresponding network topology. (i) Forest fragmentation promoted thermophilic plants, whereas forest interior habitats harbored shade- or cold adapted species. Hence a higher proportion of interactions was found on thermophiles in forest edges and fragments. These plants survived longer in climate change scenarios and therefore can sustain herbivore populations more reliably. (ii) Furthermore higher network complexity and trophic redundancy indicated a higher degree of overall connectivity and niche overlap of herbivores. Thus, upon loss of a host plant, herbivores were more likely to have alternative hosts that save them from secondary extinction

Our findings indicate buffering effects of forest fragmentation against climate change, as fragmentation-affected forests already show adaption to warmer and more extreme temperatures. This might have important implications for sustainable silvicultural practices in future forest landscapes.

O4 - Do deciduous and coniferous trees in Swiss mountain forests differ in their response to climate variability?

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Extreme climate events, such as drought periods or fast/large temperature changes, are expected to occur more often in the future. Particularly mountain forest ecosystems are predicted to be very sensitive to drought and increasing temperatures, although the extent of such effects will highly depend on forest type and species composition. Still, not much is known about the spatial and the temporal variabilities in tree growth related to climate at higher altitudes, although this information is critically needed to predict future tree responses to climate change (e.g. CO₂ increase, heat wave, drought). Due to the variety of climatic conditions given by differences in altitude, Switzerland provides an ideal framework for studying the effects of extreme climate events on relevant European tree species and mountain forest ecosystems.

Thus, the aim of our study is to assess the responses of both deciduous and coniferous mountain forests in terms of carbon fixation and water loss to extreme climate events such as drought. As a first step, we identified environmental

conditions that could be considered extreme in accordance to latest definitions (i.e., Reichstein et al. 2013) by using highly resolved meteorological data (half-hourly measurements). Then, long-term eddy covariance flux measurements at the Davos evergreen forest (since 1997) and Laegeren mixed forest (since 2004) were used to determine the responses of net ecosystem productivity (NEP) and ecosystem evapotranspiration (ET) to these extremes.

We hypothesized that deciduous trees are more susceptible to summer drought, while evergreen trees are more susceptible to spring drought. Both tree types differ in phenology, i.e., the start and the length of their growing season: deciduous trees present a longer and earlier start of the growing season than evergreen trees. Thus, maximum carbon fixation did occur in different seasons: in spring for evergreen and in summer for deciduous trees. Further detailed analyses will be discussed.

O5 - Does management of Slovenian Silver fir-European beech mountain forests need to be adapted to climate change?

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Evaluating Business-As-Usual management strategies (BAU) under future climate change is essential to examine if they are able to maintain the provisioning of multiple forest ecosystem services (ES), and if adaptive management is required to counteract adverse effects of climate change. In this context, forest succession models are valuable to assess the sensitivity of ES to climate change under BAU. We enhanced and evaluated a climate-sensitive forest succession model (ForClim) across the Alps, and implemented new algorithms for capturing specific harvesting regimes and assessing ES. The model was subsequently applied according to specific management prescriptions and different climate change scenarios in several representative Silver fir-European beech stands in the Dinaric Alps (Slovenia). These forests have a long tradition regarding small-scale system management, and they were managed for the last 200 years to promote conifers due to their higher productivity and economic value. During the typical rotation period, i.e. ca. 130-140 years, usually 4 thinning operations and 2-3 regeneration fellings were simulated in even-aged stands, while single-tree selection harvesting was applied every 10 years in uneven-aged stands. Simulation results for a rotation period reveal that the most important ES at the stand scale (timber production, nature conservation) would be maintained under BAU, but climate change will have negative effects on Silver Fir and Spruce regeneration. This was especially strong for Silver fir due to its sensitivity to both browsing and increasing winter temperatures, while European beech demonstrated vigorous growth and abundant regeneration, as confirmed by measured data. At the end of the rotation period, most of the simulated stands showed a dominance of European beech, favored by

the decline of Silver fir and Spruce due to the combination of BAU and climate change. Our results suggest that foresters should reconsider their BAU management and adapt their management strategies if they wish to maintain the current species share and preserve Silver Fir in these forests. A set of simulations under adaptive management are proposed as a suitable alternative to current forest planning.

O6 - Interdependency and specificity of measures of forest stand structure

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Almost all central European forests have been or were managed by men through silvicultural interventions, which may reduce or enhance structural/compositional variability of forests at the stand level and the landscape level. This may in turn affect level and partitioning of α -, β - and γ -biodiversity. In functional biodiversity research forest structure serves as direct and intermediate driver (i.e. proxy for forestal land use). Stand structure is commonly defined in terms of tree species abundance and composition, tree size/age variation, vertical (e.g. layering) and horizontal variation (e.g. patchiness). However, it is known that measures of stand structure tend to be interrelated and sensitive to tree species identity. The aim of the study was to quantify stand structure by using established and new measures and to analyse how these measures are related within and across components of stand structure. The effect of forest type and land use intensity on stand structure was examined.

We investigated stand structure of the forest plots (one hectare in size) in three regions in Germany (Biodiversity Exploratories: Schwäbische Alb in the south west, Hainich-Dün in the center and Schorfheide-Chorin in the north east of Germany, N = 150). These stands comprise different developmental stages (thicket, pole wood, immature and mature timber) of managed European beech, Norway spruce and Scots pine forests, managed mixed forests, managed uneven-aged beech forests and unmanaged beech forests. Data from forest inventories (full survey of all living trees with dbh > 7 cm) and airborne laser scanning were used to determine stand structural attributes.

Initial results show that stand structure across all forest types is largely controlled by tree species, developmental stage and type of silvicultural management.

O7 - Vitality indicators for a sustainable management in differently managed beech forest stands in the German low mountain range region Eifel.

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Forests represent a large CO₂ storage and fulfil many more important services for humans, such as primary production and nutrient recycling. Nowadays nearly all forest stands are cultivated in some way. To understand the consequences of certain management strategies it is necessary to find out if sustainable preservation of ecosystem functions is guaranteed.

In our study differently managed forests were investigated in the Eifel, a low mountain range in west Germany: (1) old beech forests with intact canopy structure taken out of use, (2) medium aged beech forests managed according to the single-tree selection, (3) old beech forests with shelterwood cutting leading to a patchy canopy and (4) spruce forests set up in conventional plantation style.

Different parameters were investigated to evaluate and explain tree and stand vitality. To quantify the effects quantum yield of photosystem II as well as its maximum photochemical efficiency were measured. As possible causes, photosynthetically active radiation at the forest floor, air temperature dynamics near the surface and vegetation distribution were analysed.

It was shown that trees from the cleared stands (type 3) utilised considerably less incoming energy for photosynthesis and showed a greater variation in maximum photochemical efficiency than trees from the unused forests (type 1). Additionally in the forest stands with open canopy (type 3) more heterogeneous light regime was observed, which lead to changed species composition as well as greater temperature fluctuations than in the other beech forests.

The results show that the way of management, especially the resulting amount of canopy disintegration, has a particularly strong influence on internal forest climate and radiation budget. Canopy disintegration may lead to stand destabilization and can have adverse effects on tree vitality which reduces the ecosystem resilience against environmental changes.

O8 - Contrasting responses of bird diversity and avian nest survival to edge effects and tree species diversity

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Habitat fragmentation and monoculture forestry are major drivers of species loss, but their interaction has not been explored so far. Here we test the hypotheses that high tree diversity in a large deciduous forest enhances bird diversity and nest survival. We further expect that forest edges support higher bird diversity when different habitat types adjoin, whereas nest predation is not higher, because the large forest area mitigates potential edge effects. We studied how edge-centre differences and tree diversity affect the bird community and survival rates of ground breeding birds' nests based on an artificial nest predation experiment in the Hainich National Park, Germany. We surveyed birds three times during the breeding season. We selected six forest stands dominated by beech and six with high tree diversity. Each forest stand contained four bird survey plots (in 0–30, 60–90, 120–150, 180–210 m distance from edge). Additionally, each plot corner contained one artificial ground nest baited with one Quail egg and one plasticine egg for eight days of exposure in the middle of the breeding season. Bird abundance and diversity were higher in the first 30 m of the forest. Bird diversity, including ground breeding birds, was also enhanced by higher percentages of bushes, which may provide enhanced food supply, perches as well as sheltering. Nest predation showed no edge effect. Predation rates were higher in tree-species rich stands compared to beech-dominated stands, probably due to greater diversity and density of mammalian predators. Edge effects shaped the bird community composition and positively affected abundances of tree- and shrub-breeding birds, but not ground breeders and the nest predation of ground nests. In conclusion, bird diversity and avian egg predation were affected by forest edges and tree diversity in surprisingly different ways.

O9 - Accumulation of dead wood affects non-saproxyllic epigeic species - an experimental multi-taxon approach

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In recent years, the importance of dead wood to forest biodiversity, particularly to saproxyllic species, has been widely acknowledged and thus, the retention and accumulation of dead wood is a key element in most forest conservation strategies. However, the effects of dead-wood accumulation on non-saproxyllic species is less well studied and clear conclusions regarding potential benefits for non-saproxyllics are lacking.

To evaluate the effects of dead-wood on non-saproxyllic epigeic species of several taxa (Coleoptera, Aranea, Collembola, Mollusca, small mammals), we experimentally exposed more than 800 m³ of logs and 5000 branches on shady and sunny forest plots in the management zone of the Bavarian Forest National Park. We varied the amount and diameter class of fresh deciduous (*Fagus sylvatica*) and

coniferous (*Abies alba*) dead wood and sampled epigeic taxa for one year using pitfall traps.

All species groups showed significant responses to the accumulation of dead-wood but effects of the different treatments varied between species groups. Activity densities of epigeic beetles and springtails increased with increasing amount of logs and branches and spiders showed a strong response to fir branches. All taxa were spatially aggregated in the immediate surroundings of dead-wood objects.

Our results showed that non-saproxyllic taxa not only respond to dead-wood accumulation, but most groups also benefit from it. Thus, conservation strategies aiming on higher supplies of dead-wood in temperate forests support high levels of biodiversity beyond saproxyllic taxa and should therefore further be promoted.

O10 - Increasing temperature may compensate for lower amounts of dead wood in driving richness of saproxyllic beetles

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Global warming and land-use change are expected to be additive threats to global diversity, to which insects contribute the highest proportion. Insects are strongly influenced by temperature but also require specific habitat resources, and thus interaction between the two factors is likely. We selected saproxyllic beetles as a model group because their life cycle depends on dead wood, which is highly threatened by land use. We tested the extent to which higher temperatures compensate for the negative effects of low amounts of dead wood on saproxyllic beetle species richness (*Temperature–dead wood compensation hypothesis*) on both a macroclimate and a topoclimate scale (north- and south-facing slopes). We analyzed 1,404 flight-interception trap catches across Europe to test for interaction effects of temperature and dead-wood amount on species richness. To experimentally test our findings from the activity trap data, we additionally reared beetles from 80 bundles of dead wood initially exposed at high and low elevations. At the topoclimate scale, we analyzed trap catches and reared beetles from dead wood exposed in 20 forest stands on south-facing and north-facing slopes in one region. On the macroscale, both temperature and dead-wood amount positively affected total and threatened species richness independently, but their interaction was significantly negative, indicating compensation. On both scales and irrespective of the method, species richness decreased with temperature decline. Our observation that increasing temperature compensates for lower amounts of dead wood has two important implications. First, managers of production forests should adapt their dead-wood enrichment strategy to site-specific temperature conditions. Second, an increase in temperature will compensate at least partially for poor habitat conditions in production forests. Such a perspective contrasts the

general assumption of reinforcing impacts of global warming and habitat loss on biodiversity, but it is corroborated by recent range expansions of threatened beetle species.

O11 - Identifying and protecting forest stands of special importance for biodiversity conservation: Results and implications from Northern Germany

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Following the Hotspots Strategy, a multitude of species can be conserved on comparatively small areas and limited funds can be used particularly effectively in these areas. Consequently, also conservation measures in forests should be mainly implemented in those areas, where the highest effectiveness is to be expected. In doing so, the stabilisation of centres of a typical species and habitat diversity is more effective than their restoration elsewhere. However, while there are approaches for the implementation of the Hotspots Strategy in forests, comprehensive practical solutions are still missing to a large extent.

In order to fill this gap, our project "Identification and protection of forest stands of special importance for biodiversity conservation" aims at developing, testing and validating a technique that makes it possible to identify biodiversity hotspots in temperate deciduous forests and to protect them in the long run. The project takes place in the Schleswig-Holstein state forests (Northern Germany) and focuses on biocoenoses of the mature and decaying stages in deciduous forests, as well as on moist forest communities. These habitats are of high conservation value due to naturalness, rareness and endangerment.

For identifying biodiversity hotspots, we apply the Ecological Niche Factor Analysis (ENFA) as a habitat modelling method based on indicator species, forest inventory data and historical map information on forest continuity. As a result, we get a comprehensive map of habitat suitability. Forest areas with optimal habitat suitability are regarded as hotspots. In order to verify the results of the model, we evaluate the habitat suitability of several forest stands in the field. For the identified hotspot stands, we develop management and conservation recommendations under consideration of the local situation.

O12 - Mistletoe infestation of Greek fir forests

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In recent decades, stands of Greek fir (*Abies cephalonica* Loudon) are declining and unusually high tree mortality has been observed in some years. The exact causes of fir decline and mortality have not been established although many have been proposed such as drought, climatic change, air pollution and pathogens or insects. Our studies have focused on the effects of mistletoe (*Viscum album* L.) on fir crown condition by assessing mistletoe infestation level and its effects on fir defoliation. The leaf water potential and chlorophyll fluorescence, of mistletoe and fir were also measured during a grown season. Our results showed that mistletoe infestation is related to crown defoliation. Altitude and tree height had no clear effects on mistletoe infestation. Mistletoe infestation level was lower in northern exposures. Mistletoe showed significantly lower water potentials and maximal photochemical efficiencies than the fir branches. We conclude that mistletoe increases the drought stress on trees and contributes to the observed fir decline and mortality. Mistletoe is a key causal factor of Greek fir decline that combined with prolonged dry periods could increase fir decline episodes and mortality.

This research has been co-financed by the European Union (European Social Fund – ESF) and Greek national funds through the Operational Program “Education and Lifelong Learning” of the National Strategic Reference Framework (NSRF) - Research Funding Program: ARCHIMEDES III, Investing in knowledge society through the European Social Fund.

P1 - The relevance of single-tree approaches for ecosystem services - do we need to see the trees before we see the forest?

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Scientific ecological and political debates have circled around the topic of ecosystem services (ESS) in forests. As a consequence ecosystem services have been divided into the four main categories of (i) provision, (ii) regulation, (iii) habitat or support and (iv) culture. Thus the theoretical background of these services has become widely accepted. One important aspect is the question of how to define the most suitable spatial scale. In most cases appropriate information at

the landscape level is rare and limited in its transferability to smaller spatial scales (e.g. forest stands, groups of trees). Therefore, we have identified 250 publications (time period 1900-2014) directly concerned with the effects at the single-tree level as the smallest spatial forest scale of major theoretical and practical relevance for ESS. Single-tree effects have been defined as spatially-limited ecological effects in terms of material, energy and gene flows, habitat characteristics and direct interactions. Firstly, our study has shown a high variability in the terms used in single-tree approaches for ESS (e.g. “host trees” or “retention trees”). While habitat and regulation functions were identified as the ESS categories most frequently studied, single-tree-based approaches for cultural ESS represented less than 5% of the studies. Empirical studies have become an increasingly important element of theoretical models as they have been supported by the “ecological field theory” (EFT) from the outset. Our study has shown that single-trees are key elements of forest ecosystems, but the future success of single-tree approaches in ESS will depend on (a) quantifiable spatially-explicit methods for the category of cultural aspects (aesthetics, human well-being), (b) the development of methods for the transfer of effects to higher spatial levels (additive vs. multiplicative effects), and (c) strategies to combine contrary single-tree characteristics necessary for specific ESS.

P2 - Gap regeneration patterns in an old-growth sessile oak (*Quercus petraea* L.)-European beech (*Fagus sylvatica* L.) forest in Romania

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The main aim of this research was to assess the gap regeneration structure and the main ecological gap conditions relevant for the species coexistence in a mixed sessile oak-beech old growth forest. A former study conducted in the best preserved part (32.3 ha) of Runcu Grosi natural reserve revealed a dominant small-scale disturbance pattern, which is ill-suited for the ascent of sessile oak into the subcanopy or into canopy stand. Although sessile oak is the most common tree species in the canopy layer (54% of the surrounding trees) and a particularly common gapmaker (80%), it is seldom a gapfiller. In opposite, beech is the main gapfiller (91%) despite their lower proportion in the canopy (44%) and as gapmaker (only 9%).

To identify if the sessile oak is able to regenerate in this forest a detailed investigation was conducted in 28 gaps distributed along all gap sizes. Two transects passing through the approximate gap center, were placed in each selected gap. A series (13) of circular plots were placed at the gap center and uniformly distributed along each of the two transects and also under surrounding

closed forest. The light availability was assessed by taking a hemispherical photo above regeneration in the plot center. All seedlings and saplings with a dbh < 7 cm were recorded according to species, height, browsing and status (live or dead).

The main species among regeneration layer was sessile oak, which accounted 65% of all living seedlings and saplings. Of these, 63% is smaller than 20 cm, and other 32% having a height of 20-50 cm. Only 0.4% of sessile oaks are taller than 1.30 cm. The second regeneration species (32%) is beech, with the most its individuals having height between 20-130cm (71%). 18% of beech saplings are taller than 1.30 cm height. The remaining 3% of the regenerated tree species were accounted by other 13 mixing species.

This result confirms our assumption that no lack of sessile oak individuals as seedlings is responsible for the failure of this species as saplings or gapfillers.

P3 - Vegetations dynamics in the beech forests at Serrahn Hills (UNESCO World Heritage Site)

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The study area is located in the Müritz National Park in the northeast of Germany. The forests of the Serrahn Hills belong to the last remaining semi-natural beech forests in Germany. In the last century the hills were designated as a nature reserve and forestry use was abandoned when the region becomes national park. Since 2011 they have been recognised as UNESCO World Heritage Site along with four other German forests.

In order to study the biodiversity dynamics permanent plots were established and the vegetation was recorded in ten years intervalls. The first decade of data were be analysed with multivariate data analyses. The ordinations elucidate the mosaic-cycle-concept as the main driving force and the natural cyclic regeneration could be identified the main process.

Apart from the processes of reversible patch dynamics additional processes based on changing light condition and increasing leaf litter in the ground layer can be found. These processes generate irreversible changes in trophic and long term changes related to the herb layer vegetation are taking place in space and time. It is very interesting that there is a strong regeneration of beech recruits in the beginning of this progress and then other tree species (e.g. *Acer spec.*) appear in the herb layer subsequently.

Pro tempora it is not clear if the changes depend on the degree of human impact or of supraregional events (immissions, climate change etc.) and how they will influence the forest community in the long run.

P4 - How do browsing damage and frost influence juvenile beech tree growth?

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Browsing and frost damage can have profound influences on juvenile tree growth in beech forests. We integrated juvenile tree growth as well as browsing and frost damage procedures into an agent-based spatially-explicit beech forest simulator. We assessed a range of browsing damage probabilities and frost probabilities, using different threshold tree heights for browsing damage. For the evaluation of the model, we counted the number of trees with less than four damage events after 20 years of stand growth. Overall, browsing damage turned out to have the greatest damaging impact of the three tested factors on juvenile beech tree growth.

P5 - Influence of forest management and microhabitat structure on the spider community regarding the autumnal aspect

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Given the alteration of forest management strategies in Germany over the recent years, there is a need to assess the additional value of sustainable management techniques to forest ecosystems and biodiversity. The aim of this study was to investigate the influence of forest management practices and microhabitats, as a treatment-dependent structural component, on ground-dwelling spider communities (Arachnida: Araneae) regarding the autumnal aspect. The study was conducted in the northern Eifel (Rhineland-Palatinate) comparing managed beech forests (*Fagus sylvatica*) with shelterwood cutting as well as single-tree selection, (non-commercial) beech reserves and conventionally managed spruce plantations (*Picea abies*) using pitfall traps (n=52) and shrub beating. Biotic and abiotic habitat parameters (e.g. vegetation structure, air humidity and temperature, litter height) were systematically assessed in all study sites as a potential factor affecting spider communities. All of the spider communities in the spruce forests were most significantly different from those in beech forests. Within the differently treated beech forests, significantly distinct spider communities were found within the two management types and the beech reserves. Within the samples areas five different microhabitats were defined according to their vegetation structure, amount of dead wood and canopy openness. Significant changes in spider communities have been found between microhabitats with a distinct herb layer and dead wood habitats. The results of this study reveal a direct influence of the type of forest management and microhabitat conditions on the structure of spider communities indicating an influence of ecologically managed forests on functional species

composition. Furthermore, this study was able to substantiate the concept of spiders as potential bio-indicators for sustainable forest management.

P6 - Fungal communities in different management stages of forest conversion in the Eifel National Park

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Macro fungi are nature conversion species and indicators of nature value in European beech forests. The main groups of macro fungi, Basidiomycota and Ascomycota, cover all soil ecological functions such as decomposition, pathogenesis or plant roots symbiosis.

The aim of the study was to investigate the macro fungal diversity and community during a reforestation process from spruce to natural beech forests. The current forest conversion project in the National Park Eifel is a perfect opportunity for working with a space-for-time-substitution approach to classify five differently developed stages (natural beech forest, conventional spruce stand, wind thrown area with or without deadwood and spruce-to-beech conversion stage). Each forest stage is represented in three replicates, where fruiting bodies, litter and soil cores were collected.

In total, 73 forest plant species and 306 fungi species (65% of the expected number of species, Jackknife) belonging to 166 families were observed during the field surveys.

MRPP (multi-response permutation procedures) for vegetation data showed significant differences in community composition between the five forest conversion stages and confirmed a successful *á priori* classification. CCA (canonical-correlation analysis) with fungal species and environmental parameters showed a high cumulative percentage variance indicating a high significance of pH and C/N ratio for fungal soil biodiversity. The results show the possibilities to interpret fungal community datasets from a statistics prospective.

Future task is to combine the current morphological dataset from field surveys with fungal eDNA (environmental DNA) metabarcodes detected by the Illumina high-throughput sequencing technology. This combination will reflect differences between fungal communities in different management stages of forest conversion.

P7 - Growth Dynamics of Spruce Root

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Growth dynamics reflect the influence of the environment on plants. Growth monitoring is an important tool for studies on the relationship between plants and environment. So far, however, the continuous measurement of growth is only possible for the above-ground tissues. By using a new technique, we have succeeded to measure the radial growth of a fine root of a spruce tree for nine months continuously.

Root growth begins in middle of April and ends in middle of July, and reaches about 1/10 of the trunk growth. Similar to trunk the root shrinks during the day and swells in the night. However, there is a significant phase shift to the trunk. The shift seems to depend on the soil moisture. Presumably, this phase shift is indicative of the water status of the tree.

P8 - Reading the tree's palm: species- and forest layer-specific herbivory on Central European deciduous trees

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Plant-animal-interactions like herbivory are important determinants for forest development and the physiological stage of plants. Herbivory differs between plant species and individuals but also between forest layers, where microclimate is uneven. The effect of microclimate on herbivory has been barely taken into account in recent studies. Therefore, we analysed the impact of microclimate on the interaction of leaf traits and herbivory.

A field study was conducted in 2012 in which ten different forest sites in Central Germany with different mean annual precipitation values (474 to 874 mm per year) were selected. A selection of northern and southern exposed study sites represents different microclimatic conditions. Different microclimatic niches were chosen, as upper and lower crown of adult European beech individuals (*Fagus sylvatica* L.) were investigated as well as juvenile individuals of beech, sycamore maple (*Acer pseudoplatanus* L.) and hornbeam (*Carpinus betulus* L.) in the understorey. Leaf samples were collected as an indirect assessment method for the observation of the degree of herbivory.

The sycamore maple showed higher losses of leaf tissue than beech and hornbeam. For the beech the degree of herbivory increased from upper crown to the understorey. In addition, a higher loss of leaf tissue at the northern exposition for sycamore maple and hornbeam compared to the southern exposition was found.

Herbivory depends on leaf quality like nutrients and water content as well as defence compounds. Differences between the species could be related to a different palatability of the plants. Within one species, microclimatic conditions might change leaf traits and thus influence the herbivory directly and indirectly. To exclude the structural influence of forest layers, we continue the project with young tree individuals in a greenhouse experiment.

P9 - Analyzing causal relationships between forest management practice and tree growth in beech forests using the DBH/height ratio

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Stem diameter at breast height (DBH) and tree height (H) are commonly used to quantify tree growth in forestry, but uneven-aged forest stands are difficult to compare with other stands using these morphometrics. DBH/H ratio can be used as an indirect criterion for comparing tree growth without having information about tree age and annual increment. We examined the ratio of diameter size and height (DBH/H) of individual trees in differently managed beech forest (*Fagus sylvatica*) to verify whether there is evidence for altered tree growth dynamics. It is assumed that forest management has causal influences on forest ecosystem characteristics such as stand structure, water availability and tree growth in sequence. Our study area is located in the Eifel region (Districts Hümmel and Wershofen) in the Northern part of Rheinland-Pfalz (50°N, 6°E) with management strategies classified into conventional, nature-near and totally reserved management. Three investigation sites per management class (30x50m) were selected and tree height, DBH and various environmental conditions such as topography, soil properties and micro-climate were investigated. DBH/H ratio was grouped by tree size and ANOVA was performed to find significant differences among the management classes. Climatic and environmental factors were correlated to the DBH/H ratio to find and explain causal relationships between forest ecosystem factors. It was found that the DBH/H ratio is closely related to some environmental parameters like canopy closure and micro-precipitation, indicating that tree growth dynamics are significantly determined by forest management practice, structure and water availability.

END OF SESSION 21

Session 22 - Tools for nature conservation

CHAIRS: JASMIN MANTILLA-CONTRERAS, STEFAN ZERBE

O1 - Large-scale top soil removal in degraded percolation mires - diaspore potential and development of spontaneous vegetation

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In 2013 - 2014 a pilot study was carried out to investigate conditions for a large-scale top soil removal to restore degraded percolation mires. The project area is located in the north-east of Germany in the Peene River valley which includes a very rich biodiversity. Today natural percolation mires are extremely rare. Mesotrophic types, especially alkaline habitats are very seldom. The physical and chemical features of peat changed irreversible due to drainage and agricultural usage until 2006.

Thus one objective of the study is the removal of the degraded, water impermeable and eutrophic top soil and the exposure of the undecomposed peat on an area of about four hectares. Through this intervention water may rise to the surface again and peat producing plants may resettle. A further aim is an economic approach to utilize and to market the big amount of excavated soil. So the expensive earth-moving could be partly refinanced.

A crucial question is in which way a development of spontaneous vegetation takes place and how it could be affected. Therefore in a first step a top soil removal of 400 square meters was made in March 2014. In the following months the resettlement has been monitored. To exclude side effects such as seed invasion by wind- or animal-dispersal the diaspore potential of the upper peat body was analyzed. In February 2014 six peat samples were taken and cultivated in boxes. They were kept in a cold frame and covered with fleece.

Advantages of this planned large-scale top soil removal are first of all little side effects and a big restoration area. Furthermore the excavation works without passing the bare peat - in contrast to common topsoil stripping methods. Finally the gained, removed soil is a raw material for gardening purposes. In the presentation first results of vegetation development as well as data about soil quality and water supply will be shown in detail. The pilot study was supported by the "Federal Agency for Nature Conservation" - BfN.

O2 - Herbicides in invasive non-native plant management: An estimate of usage and an assessment of non-target effects on native plants

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⁶Forest Health and Silviculture Section, Forests Branch, Ontario Ministry of Natural Resources, Sault Ste. Marie, CA

Invasive species management has become intrinsically tied to conservation and restoration efforts. Herbicides are often the first choice when it comes to eradicating and controlling non-native plants. Yet, in many cases, there is little knowledge on their magnitude of usage and their non-target effects risks although this information is important to land managers, policy makers, pesticide producers, and the general public. We compiled an estimate of herbicide usage in non-native plant management in North America and assessed how two commonly applied herbicides can affect native plants at the seed stage. According to data provided by U.S. land managing agencies, about half a million of hectares of wildlands were sprayed in 2010, alone. Although it is non-selective, glyphosate was the number one active ingredient, both in terms of area sprayed and volume used. Our estimate is much higher than that previously reported and, considering that many contacted offices did not provide data, it may represent a gross underestimate. Furthermore, our greenhouse experiment showed that Picloram and Aminopyralid significantly suppressed seedling emergence and lowered biomass, at the recommended rate. By losing their selectivity at the seed stage, these herbicides harmed non-native and native plants alike. Land managers should avoid spraying if recruitment of native species from the seedbank is a goal and should not seed directly after spraying. A continuous update of herbicide usage estimates, coupled with rigorous assessments of herbicide non-target effects and efficacy will ensure informed decision making in invasive non-native plant management.

O3 - Classification of urban tree location types considering human needs and site conditions for trees.

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Effects of urban green can be differentiated into positive influences e.g. the improving of microclimate and their function as recreational areas, and negative influences e.g. damage on properties caused by limb breakage or penetrating roots

leading to lower acceptance of the inhabitants. Urban sites are very variable according to the user entitlement and their growth conditions. Therefore, the selection of planted tree species has to incorporate these location-specific factors.

Based on urban structure data, human demands and tree needs, we developed a decision matrix aimed at classification of specific locations for urban woody plants thus providing planting guidelines.

To achieve this: i) urban structure types defined by usage and construction characteristics were listed and described for urban tree aspects, ii) human demands on urban trees including specific needs for sensitive demographic groups were structured including aesthetical and economical aspects, risks, interferences, economic, nature experience and nature conservation, iii) tree-specific needs were considered and divided into microclimatic and soil-site conditions.

Our results suggest that there are tree selection criteria such as soil conditions and light availability, which are independent of urban structure types. Some criteria, such as species-specific drought tolerance, soil compaction risks, or the importance to avoid interferences caused by trees can be categorized in relation to usage and were classified in urban tree location types.

The developed decision matrix referring to the tree location types is useful for preventing errors in planning causing high ecological and economical costs and further to increase acceptance of urban trees by inhabitants.

O4 - Effects of sustainable forestry on the biodiversity of deciduous forests

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Due to the intense pressure on land that renders the establishment of many additional large nature reserves very difficult, it is unlikely that the conservation of species in Central European woodlands can be achieved by focussing on nature reserves only. An alternative is to make current forestry more biodiversity-friendly. In recent years, a multitude of sustainable forest management strategies have been conceived and are being implemented. In most cases, however, it is unclear whether these strategies are successful. In our study we examine the effectiveness of a sustainable forest management strategy realised in an area of 128000 hectares in Beech forests in northern Bavaria, Germany, in 2005. The strategy aims to enrich the amount of deadwood in forests by a) renouncing a certain amount of wood during timber harvesting or thinning, and b) by sparing 10 single trees of high conservation value (e.g. large trees) per hectare. Thus, the strategy aims to actively enrich the amount of deadwood in forests during standard forestry operations.

We combine data from past forest and biodiversity inventories, carried out before the strategy was implemented, and from current assessments to test if a) deadwood has accumulated in the forests, and b) if the change in deadwood has led to measurable increases in biodiversity over a period of 10 years. The biodiversity data include deadwood dependent species groups like bryophytes, birds, saproxylic beetles and fungi.

O5 - Conserving savanna biodiversity through strategic adaptive management

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Conservation managers in the Kruger National Park, South Africa, are mandated to conserve biodiversity in all its facets and fluxes. Managing complex systems characterised by uncertainty is no easy task, but a strong history of science-management integration in Kruger has led to the development and implementation of a strategic adaptive management (SAM) approach within South African National Parks (SANParks). SAM embraces learning-by-doing principles, which propose that management actions should be implemented, even if based on imperfect scientific knowledge, because complete understanding of a complex system is unattainable. Furthermore, management actions present potential learning opportunities, feeding back more reliable information to improve decision-making. The SAM framework requires the articulation of an objectives hierarchy that leads to specific end-points to guide management. The development of scientifically rigorous monitoring programmes to evaluate these end-points is essential. The end-points, known as thresholds of potential concern (TPCs), are upper and lower levels of acceptable change that, when exceeded, set in motion an appropriate management response.

I will give an overview of the development of SAM within the Kruger National Park, highlight the on-going challenges of integrating ecological knowledge into nature conservation, and discuss the increasingly important role of remote sensing in evaluating conservation objectives and management outcomes.

O6 - Water hyacinth, opportunity or threat for the Alaotra wetlands?

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Species invasions are one of the main conservation threats today and have caused many species extinctions. The invasive South American water hyacinth (*Eichhornia crassipes*) is now widely spread at Lake Alaotra, the largest lake of Madagascar representing the rice granary and the biggest inland fisheries. This invasive plant species is proved worldwide to cause several severe ecological problems and at least disturbs local population daily life due to waterway clogging in the Alaotra wetlands. Proceeding control methods for the water hyacinth seems to be unrealistic due to institutional and financial limitations in the Alaotra region. One new perspective would be to use this plant (compost and handicraft) as an alternative resource to improve the livelihood of the local population. The current study collected socioeconomic data from fishermen, rice cultivators, vegetable farmers and breeders from three locations (Anororo, Andreba and Vohimarina) differing by the level of degradation of the natural habitat and identifies drivers and barriers for the usage of this plant as an alternative resource for the local populations. Results suggest that the general uncertainty of livelihood security in the Alaotra region could hinder the acceptance of new alternatives without sustained and immediate external financial and technical supports. Besides the duration of the maturation of the water hyacinth compost could block its adoption. However, the education and information of the local stakeholders are relevant drivers for encouraging the use of this plant

O7 - Clashing value systems at Lake Alaotra, Madagascar

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Madagascar is renowned for its unique biodiversity but also for the continuous degradation of its natural environment and its high poverty rate. In order to achieve sustainable development, environmental education has been assigned a key role. In the Alaotra, Madagascar's most important rice and inland fish production area, primary schools are the sole formal education for the majority of the population around the lake. This study assessed the status quo of environmental education in this region, for example, understanding local definitions of environmental education, its application and role, in order to gain an overview on the education of "tomorrow's" resource users. Over 50 in-depth interviews were conducted with teachers from 18 public primary schools administering the Funnel approach. The interviews have been complemented with focus groups and a PARDI workshop (a participatory problem analysis method).

Teachers of the Alaotra give a much less complex definition of environmental education than the United Nations. Their focus is on social aspects rather than the actual problems of the natural environment itself, thus representing a clash of values between NGOs from abroad, currently being the main promoters of environmental education in the area, with local views and needs. A lack of appropriate material for environmental education and the conviction that environmental education is already embedded in the school curriculum, represent barriers to its implementation. When developing educational programs, it is important to include the teachers in the drafting of criteria and processes to ensure that such programs are locally meaningful and useful.

O8 - The economic contribution of non-timber forest products (NTFPs) to rural household revenues in two villages of Burkina Faso

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Non-timber forest product (NTFP)-providing species are an integral part of West African agro-forestry systems, and contribute significantly to local livelihoods. Although their importance is generally acknowledged, only little information on their economic contribution to household revenues is available for this region. For the first time, a study in the South Sudanian zone of northern Benin (Heubach et al. 2011) provided corresponding economic figures. To examine the validity for other vegetation zones, comparative case studies are essential. In this study, we investigated the economic contribution of NTFPs to rural household revenues in two villages of the North Sudanian zone of Burkina Faso. We collected data in 155 households in two villages alike in the study in Benin. The income share of NTFPs in rural household subsistence revenues is calculated for different ethnic groups as well as for three income groups. Different socio-economic variables are tested against relative NTFP income to show the most important factors for NTFP dependency.

With 49% NTFPs account for the largest income share compared to the other income sources (crop production, livestock income, off-farm income) for total household income in SE-Burkina Faso. In contrast, in northern Benin NTFPs account for the second largest income share with 39%. Even though NTFP dependency is significantly higher in the case study of Burkina Faso, income structures in both regions are similar and show the indispensability of NTFPs to rural households. We found significant differences in NTFP dependency in the two villages of SE-Burkina Faso and for different ethnic groups. This could be due to different savanna

woodland species compositions in their surroundings as well as to different traditional practices of the ethnic groups. The differences between villages and ethnic groups show that management recommendations are needed on a local level as well as adapted to the livelihood habits of different ethnic groups.

O9 - A plea for evidence in ecosystem services science: a framework and its application

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The ecosystem service concept is at the interface of ecology, economics and politics, with scientific results rapidly translated into management or political action. This emphasises the importance of reliable recommendations provided by scientist. We propose to use evidence-based practice in ecosystem service science in order to evaluate and improve the reliability of scientific statements. For this purpose, we introduce a level-of-evidence scale ranking study designs (e.g. review, case-control, descriptive) in combination with a study quality checklist. For illustration, the concept was directly applied to 12 case studies. We also review criticisms levered against evidence-based practice and how it applies to ecosystem services science. We further discuss who should use the evidence-based concept and suggest important next steps, with a focus on the development of guidelines for methods used in ecosystem service assessments.

O10 - Quantitative versus management goals in biodiversity conservation: it is not all about numbers

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Target 11 of the Strategic Biodiversity Plan for 2011 - 2020 recommends to conserve at least 17% of terrestrial areas for biodiversity and ecosystem services. However, the target goes on and states that the selection of such land should be ecological representative, well-connected to existing systems of protected areas (PAs) and take into account the wider landscape. It also states that their conservation should be achieved through effective and equitable management. Hence, target 11 holds two very different components: one very specific and quantifiable, related to the amount of area to be protected, and another component, relatively subjective and open to interpretation, related to the type of conservation management implemented in the PAs.

Adhering to these goals will challenge countries in different ways. Although European Union (EU) as a whole and Brazil have already reached the goal of 17% terrestrial protected areas, we investigate here to what extent EU and Brazil have attained the management component of target 11. We look at the distribution of IUCN protected area categories as well as at the legislation for protected areas in order to realize the challenges for meeting the management goals of target 11. We assess how current conservation policies and actions respond to biodiversity needs in our two case studies and we discuss how the future policy decisions should consider global environmental change and the international political, economical and environmental contexts. Focusing on quantitative goals for conservation offers a truncated image of conservation progress and we argue here that more attention should be given to the management aspects of conservation.

O11 - Animal-aided design-bridging the gap between landscape architecture and conservation

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Biodiversity underlies many of the ecosystem services demanded by humans. For the provision of these services and the preservation of biodiversity, the design of a 'green infrastructure' has been proposed. It is unclear, however, how this green infrastructure should be created. Urban green spaces are currently planned by landscape architects with a primary focus on aesthetic design. As a consequence, conservation may often spoil the design, e.g. when the need to conserve a protected species demand modifications of the project. Conversely, conservationists are often in favour of protected areas, with little access of humans and no human design.

Here we propose 'animal-aided design' (AAD) as a methodology for the design of urban spaces. The basic idea of AAD is to include the presence of animals in the planning process, so that they are an integral part of the design. For AAD, the desired species are chosen at the beginning of a project. The requirements of the target species then set boundary conditions and serve as an inspiration for the design. The aim of AAD is to establish a stable population at the project site. We illustrate our approach with designs for urban spaces in Munich, Berlin and London

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O12 - Monitoring the Effectiveness of Habitat Conservation in Switzerland: How to assess changes in 6000 habitats of national importance on the national, regional and local scale

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In the last thirty years, Switzerland has established inventories of its dry meadows and pastures, alluvial areas, bogs and fens, and amphibian breeding sites. As a consequence of this process, the most valuable of these habitats are now protected by law as "habitats of national importance" and are forming the most important element of the Swiss protected areas system. Although the total area of these habitats is less than two percent of the total area of Switzerland, they are very important for the long-term survival of numerous rare and threatened species.

Legal protection of these habitats of national importance, however, does not necessarily ensure the preservation of their ecological quality or conservation value. The main aim of the long-term project "Monitoring the Effectiveness of Habitat Conservation in Switzerland" is to inform the Swiss government about the development of the habitats of national importance with respect to both size and quality. The project also provides an early warning system, detecting negative developments as early as possible and allowing the authorities to respond in time. The focus of the project is mainly on the assessment of national and regional trends, but changes in individual sites should also be detected. Since demands upon a monitoring system can change, for example due to new societal or environmental policy conditions, the data assessed must allow for a range of analyses.

In this talk the project will be introduced together with its background and its different modules for data assessment. I will discuss scientific and governmental project requirements and how we solved various challenges.

P1 - Influence of media coverage and leaf damage by the horse chestnut leafminer *Cameraria ohridella*, on perception and evaluation of impersonal risks

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Information about environmental change and associated risks are communicated to the public mainly through mass media. However, the subjective assessment of environmental risks is not only based on media information, but also on the individual perception of the environment. As model organism we use the invasive horse chestnut leaf miner *Cameraria ohridella* Deschka & Dimic (Lepidoptera: Gracillariidae), which causes a distinctive pattern of damage to white flowering horse chestnut trees (*Aesculus hippocastanum* L.) resulting in premature defoliation in summer, and often total loss of foliage by midsummer. This "environmental change" is directly observable for citizens in Germany. We chose 12 different regions in Bavaria and Schleswig-Holstein with two different levels (low and high) of infestation of horse chestnut trees in a paired design, where regions were matched according to demography. Randomly chosen people (between 18 and 60) were exposed to one of three newspaper articles differing in linguistic quality, complexity and fragility. These articles were incorporated within an online questionnaire which was questioning variables such as personal relevance, environmental change perception, subjective risk perception, information processing and the individual's change of behavior. We investigated how different information from mass media about *C. ohridella* is processed by the public and which correlations with the individual perception of the leaf damage show up. Second we examined relevant factors for the subjective perception of risk. These relationships are essential for explaining individual behavior and adaptation in regard to environmental change, which is of high interest for science communication.

P2 - Changes in bryophyte communities on decaying firs and the influence of microclimate.

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Dead wood is substrate suitable for many groups of organisms. Epixylic bryophytes are one of them. Many species are dependent on this type of substrate and sufficient amount of the high-quality decaying wood in the forest is necessary for their occurrence and also protection. The succession of the dead wood inhabiting bryophyte communities is closely associated with the process of decay and reflects the physical and chemical changes of the substrate.

In this study we focused on bryophyte communities on decaying firs in mixed beech-fir forest in Salajka nature reserve in Moravskoslezské Beskydy, Czech Republic. We sampled 72 *Abies alba* logs divided into two data-subsets. In the first data set there were logs in all decay stages to describe the succession of the bryophyte communities during the decay. In the second data set there were only logs in the advanced decay stage and here we focused on the influence of the microclimate on the communities composition and species covers.

We found out that there is a clear pattern in the succession of the communities correlated with the decay stage of the log. We also found out that the microclimate influences only species considered as dead wood specialists (e.g. *Cephalozia bicuspidata*, *C. attenuata*, *Nowellia curvifolia*). All together we found 64 species, 9 of them considered as regionally threatened or requiring attention.

P3 - Restoring dry grassland community on a limestone quarry surface: comparison of different types of management

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Man-made habitats, such as limestone quarries, have been many times suggested as the potential refuges for endangered plant species, especially when present in the vicinity of species source. However, the development of a valuable community might be inhibited either by harsh abiotic conditions or by competition of ruderal species or limited by propagule availability. In these cases, some management practices such as mowing or sowing of the target species can be useful.

We studied seedling establishment and vegetation development on a limestone quarry landfill under four different management treatments: spontaneous succession (control plots without any management), mowing, sowing of 28 target dry grassland species and a combination of mowing and a hay transfer from the adjacent grassland. The quarry landfill is located next to valuable dry grassland and was created in 2008 by filling-up the post-mining pit with the clay material from the bottom of the quarry. The experimental plots (1x1 m, 30 plots per treatment) were established in 2009 and the vegetation was observed for the following three years.

During three years, we found 23 grassland species on plots without management. However, distribution of these species was spatially limited (in contrast with the managed plots): the grassland species reached only plots present less than 20 meters from the species source, the adjacent grassland. Though we have not observed any influence of management on vegetation composition yet, various management treatments showed significant effects on germination, seedling establishment and seedling species composition. Germination was negatively influenced by mowing, whereas hay had a positive effect on number and also on composition of germinating species. Mowing had also influence on species composition of established seedlings. In contrast, we found no effect of hay on seedling establishment.

Our results proved that there can be important constraints in restoration of man-made habitats. Besides of the limited propagule availability, the harsh environmental conditions on the landfill cause low survival of germinating species. As the germination rate was the highest under the hay-transfer management, we suggest this approach as the most effective in restoration of such sites, mostly in cases of low propagule availability. The mortality of germinated seedlings might be decreased by repeated usage of this management practice as the hay could create more hospitable conditions.

P4 - Using ecosystem function models as a tool for integrating ecosystem services into landscape management decisions

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Land use and the resulting land cover changes alter the capacity of ecosystems to provide vital services for human well-being such as fresh water supply, climate regulation (e.g. through carbon sequestration) or the maintenance of soil fertility. To sustain ecosystem functions and prevent further degradation of ecosystems the concept of ecosystem services has become an important area in conservation planning. Appropriate indicators and reliable assessment methods for their quantification are needed that integrate ecosystem services in regional decision making processes. Ecosystem service supply can be assessed and transferred to different spatial and temporal scales by linking land use information and abiotic data by means of GIS based modelling approaches,.

In the context of the JAGUAR-project in Hesse, Germany we aim to develop strategies and methods for the sustainable use of cultural landscapes to meet the diverse needs of human societies. For that matter we apply existing ecosystem

function models (such as the Catchment Modelling Framework), which allow for quantifying ecosystem functions related to the hydrological, nitrogen and carbon cycles, in order to analyze storage and fluxes of key components of physical and biogeochemical processes that largely determine both provisioning and regulating ecosystem services. These models are used to illustrate different possible trajectories based on land use scenarios. We present effects of different land use options on ecosystem processes such as carbon sequestration, ground water recharge, erosion risk and the resulting supply of ecosystem services. The implications for different stakeholders are discussed.

P5 -The perception of nature and nature conservation in national parks in Patagonia, Argentina

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There are numerous studies concerning the contentment of visitors of national parks in Argentina. However, little is known about the general perception of nature and about the impact of spending time in nature on people's attitudes and emotions.

More than 200 visitors were interrogated with pre-post questionnaires while visiting different areas of the National Parks Lanín and Nahuel Huapi in Northern Patagonia. The questions were built as "items" on the one hand or allowed for "free text" on the other hand. Some of the questions were identical to those of a pre-post-interview that took place in three German National Parks (Tölle, 2012). The answers will be analysed i) for the effects of experiencing nature, ii) for underlying demographic and educational components, and iii) for the differences of people's perceptions between two continents.

A preliminary glimpse on the answers revealed a tolerant attitude towards exotic or invasive species in Argentina. Interestingly, most of the visitors to Argentinean national parks associate the term "nature" with just "life", while in Germany these were only 13% of 300 interrogated visitors.

The results of the ongoing statistical analyses will be presented and discussed.

P6 - Successful transplantation of a meadow of Molinion (Code 6410 of FFH directive)

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Molinia meadows are rare and threatened. They are listed by the European Union as the habitat type "*Molinia* meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*)" under the Natura 2000 Code 6410 of the Fauna-Flora-Habitat directive with high interest for conservation.

Threatened by the construction of a new highway (A 39) a species rich meadow of *Molinion* was relocated in 2006 by turf transplantation to a safe former arable land.

We started a monitoring including a first record of the species present in 2005 before the measure was conducted. Since 2007, annual censuses of the population size of Red List species and annual compilation of the flora and implementation of vegetation surveys on permanent plots have been carried out.

The preservation of the flora was successful. The mean abundance of the species of 2005 was until today about 90%. Focussing the indicator species of the habitat type, a substantial loss was recorded for the population sizes of the endangered species *Serratula tinctoria*, *Betonica officinalis*, and *Selinum carvifolia*. However, until 2013, the population size of these species reached the initial prior the transplantation. *Galium boreale* and *Silaum silaus* could not reach their initial population sizes but were found to have large numbers.

The number of species on the transplanted meadow has almost doubled after translocation, which has been caused particularly by an increase of weeds. A slight decline of the number of weeds could be observed so far, however, the coverage of these species on the permanent plots was low.

In 2005, the *Molinia* meadow before transplantation (donor site) and the control sites of the same vegetation type nearby had a similarity (Jaccard index) of 81% of common species. After transplantation, the similarity declined. Not only the transplanted meadow changed, also the control sites showed an increase in the number of species. Neither the control site nor the transplanted area showed strong changes in the indicator values for nitrogen and moisture (Ellenberg values).

During the study (2005 - 2014) the classification of the *Molinia* meadow as habitat type 6410 of the FFH directive has not changed. However, there are tendencies for mesophilic grassland and in hollows for flood meadow. In sum the measure was successful.

P7 - Using historic data from the early 1970s to ascertain changes in biodiversity as a basis for nature conservation

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Spatiotemporal heterogeneity is a functional component of ecosystems. Although the development and structural change of habitats is obvious, the major difficulty is the documentation of the change in biodiversity. Environmental surveys with a

reproducible spatial reference (permanent plots) and comparable methodology in a certain time period are needed for the record and assessment of vegetation dynamics and are a basis for nature conservation. The availability of appropriate data to detect and describe this kind of changes in habitat structures and biodiversity presents the first challenge. The second is the preparation of historic data being available in an analog format. Today, most environmental data are available in a digital multimedia format. This may include datasets from vegetation surveys in spreadsheets as well as maps with their comprehensive metadata as vector data for a GIS and a detailed description of the methodology.

We processed analog data from the early 1970s of the protected area “Sager Meere, Kleiner Sand und Heumoor“, also part of a European Habitat Directive area, in the administrative district of Oldenburg, Lower Saxony. The aim was the reconstruction of permanent plots and repetition of the surveys with exactly the same methodology in order to record and assess alterations in the fragile ecosystem of two oligotroph waters, moor and heathland.

Above 200 spatially located surveys and a detailed map of the vegetation structures have been digitalized in many steps to aim a complete dataset for re-surveys, of which most have been carried out in this summer. As first results we recorded an increase of 20% in forest habitats and shrubs and a decrease of 15% in moor and heathland habitats. Former occurrences of *Lobelia dortmanna*, an oligotraphent plant species of conservation interest, have been disappeared in the study area. As one cause of the detected alterations, we assume an increase of nitrification due to atmospheric deposition of nitrogen and nutrient input via the groundwater.

P8 - Ecological restoration of urban areas using native seed mixtures

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Urban demolition sites and brownfields are areas with strongly altered environmental conditions. Depending on urban development they can have a relative short lifetime and be covered again by buildings or other infrastructure after a few years. On the other hand, in shrinking cities they are often abandoned for long times. These areas generally exhibit ruderal vegetation, often with a high proportion of non-native invasive plant species. Sometimes, so-called ‘wasteland’ areas are re-vegetated with species poor seed mixtures containing cultivars of native plant species, because they are regarded as eyesore by urban planners. These areas provide a great opportunity for restoration science and urban planners to study effects of different restoration measures in urban and suburban areas. Restoration of urban demolition sites by re-vegetation with native plant species seems to be a fruitful approach aiming to develop ecosystem services like aesthetic values for recreation as well as values for nature conservation such as promoting

diversity of native species. The aim of our project is to develop restoration strategies and techniques to enhance biodiversity and ecosystem services of urban areas by near-natural restoration approaches. In spring 2014 we started an experiment on the effects of low- and high-diversity seed mixtures on vegetation succession and the establishment of invasive species. We sowed two different native plant seed mixtures with similar density in a block design at an urban demolition site of about 10.000 m² in Osnabrück (Lower Saxony). In cooperation with local authorities interested in low cost management, we will also study effects of different management measures on species establishment and persistence as well as on aesthetical value during the next years. First results from vegetation analyses in summer 2014 will be presented.

P9 -Long lasting use of nests by birds of prey

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The big nests of birds of prey often were used for many years, sometimes by generations of the same bird species. Long term investigations showed, that the species which uses a nest can change. Exemplarily, the rotation in use of nests by Common Buzzard and Northern Goshawk from mixed forests at the Sauerland border (Germany) is presented. Some of the nests were in use for more than ten years. In the given forest stands several nests are available for the birds. How constant the same location is used for nesting each year seems to differ between the individuals.

Such long term observations are possible by intensive activity of interested amateurs only, which are willing to give their data into a comprehensive database. For coordination of all the people and the provided data an umbrella organization is needed which keep in contact with the observers, collect and edit the data and provide it for monitoring programs on higher scales.

P10 - Designing a monitoring concept of severely threatened fens in Brandenburg

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The conservation of natural fens and the restoration of degraded ones is a priority aim in the nature conservation in Germany. Developing restoration methods and transporting the concepts into strategies to improve the situation in severely degraded fens is the traditional way to preserve the threatened habitats. But what is about the quantitative and qualitative evaluation of outcomes of the projects?

The study is carried out on the site of “Bergen Weißacker Moor”. It is a degraded fen located in northeast part of Germany (Brandenburg). The research area is in the northeast part called “Bergener Moor”. The status from the fen is influenced by a vast coal mining area in close proximity. The coal mining activities are completed. But the outcomes from this encroachment are still visible within the landscape. Former agriculture use, illustrated by the drainage channels, indicates an altered water cycle in this area. To prevent advancing peat mineralization the drainage channels will be closed in June 2014. The main object in the study is to obtain informations about the peat thickness and the state of peat degradation.

For designing a long-term monitoring concept it is necessary to determine significant examination points. In the master thesis these monitoring points will be defined. In the first step several soil samples will be collected along two catenae from southeast to northwest in the “Bergener Moor”. During the excavation of the samples a special bailer for fen sites is used. The degradation levels are defined with the scheme to Von Post DIN 19682-12. To identify the peat type a standard manual for soil science is used. After the soil parameters were determined a surface map will be created with GIS to obtain some information about the peat distribution in the observation area. The GIS based analysis is the basis for fixing additional investigation points to get more information about the present status. Detailed knowledge about the peat layer allows defining points which are suitable as long term monitoring sites.

The knowledge about effectiveness of the executed measures and present status of the studied area allows creating suitable concepts for improving and conserving fens as a functioning system.

END OF SESSION 22

Session 23 - Herbivores and rewilding in nature conservation

CHAIRS: CHRISTOPHER FAUST, TORSTEN RICHTER

O1 - Towards a European policy for Rewilding

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During the last century, the policies of nature conservation and the designation of protected areas in the European Union went from strict protection to the progressive inclusion of humans and their activities in the established areas. The importance given to human activities is also illustrated when policies integrate the conservation of biodiversity in sectoral activities such as agriculture. Nonetheless, millions of hectares of agricultural land could be released from human pressure within the next decades in Europe. Rewilding presents a great opportunity to restore the abandoned landscapes, along with the biodiversity and the supply of those ecosystem services that were until now restricted to the remaining few wild areas of the continent. As a result, rewilding is in a dire need of a policy framework in the EU, to promote its implementation as a land management option, to evaluate its outcomes, and to share knowledge and good practices among stakeholders. We first present the history of conservation policies and protected areas in the EU, and the relationship between conservation and agriculture. The growing importance given to wilderness areas and the inclusion of wilderness management into European policies is then discussed, keeping in mind the global and EU conservation targets. Finally, recommendations are made to efficiently and adequately include rewilding into the European framework of conservation policies.

O2 - Grazing coastal grasslands with large herbivores - Effects on biodiversity on multiple trophic levels

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Grazing with large herbivores is a frequently used tool in nature conservation to increase grassland biodiversity. However, many studies focus only on the diversity of a single target group such as *e.g.* plants. These groups are probably all affected in different ways both directly and indirectly. Direct effects include for example disturbances through trampling, while indirect effects include a reduction of food availability or light competition. Many of these indirect effects are connected to the

encroachment of tall plant species which are repressed by grazing. Such effects of grazing on diversity are most commonly studied for plants. However, can we assume that this group is a good indicator for others, such as invertebrates or birds, as grazing might affect these in various ways? Therefore, we studied the effects of two different livestock species and two stocking densities on diversity and/or abundance of plants, pollinators, birds and voles in a large-scale grazing experiment in a coastal salt marsh. We found plant species diversity to be higher under higher stocking densities. This result is probably caused by a reduced encroachment of the tall grass *Elymus athericus* under high stocking densities. In contrast, the abundance of pollinators is higher in low stocking densities, which is connected to a taller canopy and a higher number of flowers. No effect of the grazing treatments was found on birds. Voles, however, were clearly reduced by higher stocking densities and by horses compared to cattle. This result is likely connected to direct disturbance by a higher number of animals and by the more active horses. Additionally, voles might avoid treatments with a lack of tall vegetation which forms camouflage against predators. We can conclude from this study that it is difficult to assess effects of grazing on biodiversity based on one group, as various groups are affected in different ways both directly and indirectly.

O3 - What restricts generative regeneration of *Calluna vulgaris* in a continental region: seed production, germination ability or safe site conditions?

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Heathlands at the edge of their distribution (eastern, continental region) are often heavily degraded by an over-aging and disappearance of earlier age stages of *C. vulgaris* due to land abandonment and changing environmental conditions. Therefore, a large-scale field experiment in an abandoned former military training area in Eastern Germany (Oranienbaumer Heide) with free-ranging Heck cattle and Konik horses was implemented to test their effects on over-aged *C. vulgaris* populations in heaths and mosaics with dry basophilic grasslands. In addition, combinations with a onetime cutting management, as well as small-scale disturbance-events were tested.

Grazing and onetime cutting promoted the vegetative regeneration. Small-scale disturbance-events supported generative regeneration especially in *Calluna* dominated stands. However, all combinations of management did not initiate a considerable increase in generative regeneration. For that reason, other possibly limiting factors were studied: seed production, germination ability, safe site conditions. Seed production of over-mature *Calluna*-stands was extremely variable, ranging from 139639 to 760451 seeds m⁻² but not lower as reported for other heaths in literature. Germination experiments showed no significant differences between seed germination of different *Calluna* ages. Safe site conditions are crucial

for a successful generative regeneration of *C. vulgaris* field. Short distance to the nearest adult *Calluna* individual, moderate shadowing and high proportion of bare soil significantly supported the generative germination and survival of seedlings.

In conclusion, the limited germination did not result from the mostly over-mature stands in the study area: production of high quantities of seeds, no limited germination ability of seeds. Safe site conditions are crucial but not alone responsible for a successful generative regeneration of *C. vulgaris* field. Other reasons, especially water limitation in the germination period due to lower spring/summer precipitation (climate change) also seem to be an important restricting factor in continental regions and will be studied in the future.

O4 - Seedling establishment of a main encroaching species (*Acacia mellifera*) under fire & herbivory on Namibian semi-arid savannah rangelands

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Unsustainable land use (i.e. overgrazing, altered fire regimes) has led to shrub encroachment in savannas worldwide. Shrub encroachment is considered as a major form of land degradation that seriously threatens savannah biomes which are of global economic, social and conservational importance.

Although fire management is a promising tool to mitigate bush encroachment, farmers are often afraid to apply this option and even prevent natural fires. An alternative strategy may be the introduction of browsing wild antelopes that may feed on bush seedlings and saplings. However, the potential of browsing wild animals remains surprisingly unexplored.

In this study we assessed the potential of herbivory by browsers combined with fire to counteract woody plant encroachment.

In a field study, we assessed sapling survival and fitness of a main shrub encroacher (*Acacia mellifera*) under game browsing and cattle grazing combined with a natural fire in a Namibian semi-arid savannah landscape. In particular, we determined the survival and growth A) on fenced (browser enclosure) vs. unfenced site, B) at three different microsites (canopy, grass, bare soil) and C) along a shrub cover gradient. Browsing animal species were identified with camera traps. Additionally we evaluated the sapling's survival and recovery rate five months after the natural fire under A) heavy game herbivory and B) moderate cattle herbivory.

Results from camera traps show that springbok exert the main browsing pressure on 2-3 years old *A. mellifera* saplings. Fencing experiments show a slightly suppressive effect of herbivory on the sapling's growth rates and thus on the recruitment into larger size classes, which affects their survival rate indirectly by keeping them for a longer time in a fire vulnerable state. A second fencing

experiment of young germinating seedlings also suggest a strong direct effect of herbivory and trampling on their survival rates within their first 4 weeks of live. This confirms that selective browsing of tree seedlings has a filter function for the future canopy layer being most effective within the first few weeks after germination.

Implications for the applicability of herbivory and its combined effects with fire as a potential new management tool against bush encroachment will be discussed.

O5 - Reviving wood-pastures for biodiversity and people: ecological and social aspects of wood-pasture management in Estonia

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Semi-open grazed habitats, such as wood-pastures, are major resources for biodiversity in Europe. However, they continue to decline due to the loss of low-intensity grazing. Estonia introduced an innovative subsidy scheme in 2001 to halt the loss of semi-natural habitats such as wood-pastures. However, it has not been investigated how Estonia's wood-pastures and their managers are responding to the restoration stimulated by the subsidies. Our interdisciplinary study therefore aimed to (i) provide general structural information about this understudied habitat, (ii) compare old, restored and abandoned wood-pastures, and (iii) determine the motivations of farmers to use wood-pastures. We studied 30 wood-pastures and 10 control forest sites in summer 2013 in western Estonia, measuring structural attributes of the tree layer (DBH, tree height, species composition and canopy closedness), and the herb layer (cover of grass, forbs, moss, woody debris and bare soil). In addition, semi-structured interviews were carried out with the wood-pasture managers, investigating the history of wood-pastures, current management, benefits of wood-pastures and decision-making regarding subsidy payments. We found that restored sites were structurally very similar to old wood-pastures, suggesting that restoration is effective in re-establishing stand structure and therefore ecosystem dynamics. Interviews showed that wood-pastures were part of traditional farming in Estonia and are kept mostly because of this, but could

not be maintained without the subsidy payments. Our results therefore underline the importance of the subsidy system in Estonia to support semi-open habitats. However, the maintenance of woody pastures is labour and cost intensive, and many farmers are unable to expand their wood-pastures due to this. Wood-pastures could therefore benefit from value added production or ecotourism.

END OF SESSION 23

Session 24 - Ecological risk assessment and management

CHAIRS: MIRA KATTWINKEL, OLIVER JAKOBY

O1 - Same same but different? How soil texture impacts the degradation risk of dryland rangelands under altered precipitation

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Dryland rangelands are characterized by complex interactions between water and vegetation, which are highly dependent on the present soil conditions. When water becomes sparser or more abundant with global change, the plant composition and biomass will adapt. In turn, this will feedback on hydrological fluxes. The extent of these responses and the risk of degradation may differ on small spatial scales (e.g. within one farm), since soil texture can be quite heterogeneous. While field researchers and local farmers are well aware of local short-term responses of vegetation to single precipitation pulses, long-term ecosystem responses are difficult to assess solely by observations because complex feedbacks are triggered by any change of water or vegetation. Therefore, long-term process-based modelling approaches are required to guide our assessments on ecosystem responses. However, these models have long neglected the role of the temporal distribution of precipitation on soil water availability and vegetation response.

In this study, we systematically test the role of intra-monthly precipitation distribution on vegetation dynamics and water fluxes for different soil textures. For this, we apply the process-based, spatially-explicit ecohydrological model EcoHyD, which simulates the fate of surface water and water in two soil layers as well as vegetation dynamics of different plant functional types. We find that the impact of climatic changes is sensitive to the prevailing soil textures, which for example includes a limited infiltration but also slower water losses by evapotranspiration for clayey sites in contrast to sandy sites. We then evaluate, how this impacts long-term vegetation dynamics and the risk of degradation under different precipitation scenarios to assess if similar changes in climatic conditions will have similar implications for different soil textures or if resulting vegetation changes are highly dependent on the specific environment. An improved understanding of these changes will for example help rangeland farmers to understand the likely shifts in vegetation they have to expect in the future and if these shifts will occur farm-wide or are dependent on the small-scale environment.

O2 - Response of plant community to extreme hydrological conditions in floodplains at the River Elbe

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The typical fluctuation of inundation in spring and periods of drought over the summer affect the plant species in floodplains. Due to climate change these fluctuations could increase. Furthermore, non-standard extreme inundations in summertime may occur more often. So far, there is little knowledge about the species responses to this hydrological change. The central question is whether plant communities are able to buffer unusual inundations that may occur more frequently and extreme droughts in summertime that may last longer.

In a monitoring project, vegetation data of floodplain meadows were collected from 1998 to 2013 (eleven collection years). The study sites in the active floodplain of the Middle Elbe cover typical grassland communities (flooded depressions, wet and moist grassland). 60 sampling plots of 100 m² size were established and the vegetation in these plots was recorded twice annually.

In the investigation period several unusual hydrologic events occurred: the summer floods of 2002, 2010 and 2013 as well as the extreme low water period in the summer of 2003. Effects of these events on the plant species are clearly identifiable: several species disappeared for some years others dispersed higher up into the floodplain. However, species composition in the samples recovered almost completely from these extreme events because the time between the events seemed to be long enough. We used some biological traits, such as lifespan, leaf anatomy and dispersal type of the plant species to understand the changes of the plant community due to the effects of extreme hydrologic events.

O3 - Disentangling the role of species characteristics and introduction history in establishment success and spread of ornamental alien plants

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Much research in invasion ecology aimed to identify traits that promote alien plant invasion. However, the importance of introduction bias has been so far overlooked. Whether species with specific trait values were introduced earlier vs. later, or in greater vs. smaller numbers, and whether such a bias changed over time, may be critical to the success of alien plants in their new range. Additionally, by focusing on successful introductions while neglecting failed ones, previous studies may have credited some traits a role in invasion, when species with these traits were merely

preferentially picked up and introduced, whatever the subsequent fate of the species in the new range. To avoid spurious relationships, it is necessary to consider introduction bias, and to distinguish between direct and indirect (i.e. through introduction bias) effects of plant traits on invasion success. Here, we focused on ornamental plants introduced in central Europe and in Great Britain. For both regions, we aimed to assess (1) the determinants of establishment success among aliens, and (2) the determinants of spread in the wild among established aliens. We combined data on introduction history (year of introduction, planting frequency), species characteristics (native range, plant traits) and success in the new range (establishment status, current distribution). We analysed the two datasets using path analysis. We considered the year of introduction and planting frequency as both response (to native range and plant traits) and predictor (of establishment or spread) variables. Furthermore, we could estimate total, direct and indirect effects of species characteristics on establishment and spread. For both datasets, we detected strong introduction biases. We found that both the year of introduction and planting frequency significantly affected establishment and spread. On the other hand, most species characteristics included in our analysis had strikingly little direct effect on establishment success and spread. For several of them, the indirect effect accounted for an important part of the total effect. Overall, our results suggest that introduction bias matters even more than commonly acknowledged.

O4 - Potential alternative food sources for the invasive ladybird *Harmonia axyridis* in ecological compensation areas

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Introduced beneficial insects can turn into a risk for biodiversity when they outcompete local species. Once released, biocontrol organisms can spread and propagate themselves and therefore it is important to assess potential environmental risks before the introduction of organisms into new areas. One possible factor for enhanced competitiveness of introduced species could be the use of alternative food sources when prey is scarce.

We used the invasive harlequin ladybird *Harmonia axyridis* as a model organism to study the effects of alternative food sources present in ecological compensation areas on its development and reproduction. Laboratory experiments demonstrated that larvae of *H. axyridis* developed and produced offspring when reared on single food sources such as aphids (*Acyrtosiphon pisum*), lepidopteran eggs (*Ephestia kuehniella*) and maize pollen (*Zea mays*). In contrast, diets composed of only lepidopteran larvae (*Spodoptera littoralis*) or buckwheat flowers (*Fagopyrum esculentum*) were not sufficient to produce fertile adults. When fed a combination of these two suboptimal food sources, however, some *H. axyridis* larvae successfully developed into adults and even produced offspring. In further

experiments the utilization of particular plant species was investigated under laboratory and semi-field conditions.

The results show that the harlequin ladybird is capable to sustain itself not only on optimal prey, but also on alternative, plant derived diets. This could give this species a competitive advantage over native species that depend on aphids for their reproduction. Our findings for *H. axyridis* suggest that the ability of a beneficial organism to feed on alternative food sources should be considered during the environmental risk assessment.

O5 - A novel test system for risk assessment of GM crops on earthworms considering European biogeographical regions

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Within the framework of the EU project AMIGA, a laboratory test system for standard testing of the impact of GM maize and potatoes of selected European biogeographical regions on earthworms as important non-target decomposers was developed.

The system bases on earthworm species of significant functional relevance in the different European AMIGA sites (Ireland, Sweden, Spain), belonging to three biogeographical regions (Atlantic, Boreal and Mediterranean). To trace respective focal earthworm species, defined here according to the EFSA ERA guidance document (EFSA, 2010), a literature survey was conducted on species diversity, abundance and specific functional relevance. According to the availability of species, their suitability to testing under laboratory conditions and the sensitivity of different performance traits against GM plant residues, the species *Aporrectodea caliginosa* (secondary decomposer) and *Lumbricus terrestris* (primary decomposer) were finally selected to be included in the standardized laboratory test system.

Based on both selected focal species, microcosm feeding experiments were carried out with plant residues of GM and conventional non-GM crops collected from the AMIGA field sites. The risk assessment focuses on performance traits, describing growth, reproduction and survival, as the three main components of fitness (Violle et al. 2007). Matching the extended definition of a functional trait for soil invertebrates proposed by Pey et al. (in press), biomass, cocoon production, percentage of cocoon hatching, as well as survival, biomass, growth and development of offspring as relevant traits to conclude on potential long-term effects and changes in ecological functions are analysed. Considering current literature data on culture techniques for soil dwelling earthworms (Lowe & Butt 2009), appropriate laboratory conditions and a reproducible experimental design were developed.

Approach, methods and results of the test system will be presented and discussed.

O6 - Risk characterization of non-target grassland communities: modelling population and community effects of herbicide drift

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Plant communities located on the edge and in the neighbourhood of arable fields are potentially impacted by various agricultural practices including the use of fertilizers and plant protection products. Due to drift effects caused by application measures or wind, these agents can reach non-target terrestrial plant (NTTP) communities and thereby may cause shifts in their composition or in species abundance.

Using an individual- and trait-based spatio-temporal community model ('IBC-grass') we analyse potential herbicide drift exposure effects at the level of plant populations and communities (e.g. decrease in diversity or biomass). Direct (e.g. increased mortality) and indirect effects (e.g. changed competition effects) are predicted using individual-level effect pattern obtained from ecotoxicological standard studies for model parameterization. The novel modelling approach allows simulating separate or combined herbicide effects on reproduction (e.g. seed production, seed survival or seedling emergence), growth and survival of established plants. Results show the importance of timing of herbicide application relative to the plants life-cycles and the role of indirect effects for composition shifts under high exposure rates.

Current risk assessment schemes consider only individual-level effects. They do not take species interactions into account. This presented local-scale approach has the potential to contribute to a more integrated risk assessment for NTTPs addressing Specific Protection Goals (SPG) on population and community level as defined in the guidance document of the EFSA. In combination with a model addressing herbicide exposure and individual-level risk at landscape-scales ('Xplicit') our approach will allow to integrate spatio-temporally varying exposure at different spatial scales. By further investigations and validation, this approach can provide a useful tool for predicting and quantifying potential effects of herbicides on NTTP communities.

O7 - Estimating global distribution of agricultural insecticides in surface waters

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One of the main drivers of worldwide biodiversity loss in freshwater ecosystems are agricultural pesticides. Pesticides differ from other environmental chemical as they are intentionally released to the environment and designed to efficiently control pests and weeds. These characteristics lay the foundation for widespread potential effects of pesticides on non-target organisms. However, global exposure pattern and the extent of potential ecological effects are unknown. In this study, we estimate the potential for agricultural insecticide runoff into streams using a spatially explicit model. Additionally, we separate natural factors driving aquatic exposure from those under human control. We find that in the northern hemisphere insecticide runoff follows a latitudinal gradient that is mainly driven by application rate. In contrast, in the southern hemisphere, a combination of rainfall intensity, terrain slope, share of agricultural land and application rate determines runoff. In total, water bodies within 40% of the global land surface are at risk of insecticide surface runoff. When compared with field observations from small streams, model predictions were found to match the upper limit of measured exposure reasonably well. Our study provides a global map of risk hotspots of insecticide contamination that can aid freshwater management and mitigation measures.

O8 - Propolis and bee health - Does propolis reduce viral loads in honey bees?

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Honey bees (*Apis mellifera*) attract a variety of pests and parasites. Therefore they evolved several individual and communal defense mechanisms. One effective protection against pathogens is the use of plant resins which bees collect from various tree species and incorporate it in their nests where it reduces bacterial loads. Propolis also affects varroa mites, one of the most challenging disease agents

for honey bees and the main driver for colony winter losses. Mites that were exposed to ethanol extracts of propolis showed lethal, narcotic or sublethal effects, depending on the extract concentration. However, these tests were conducted with mites directly exposed to propolis extracts, whereas it remains unclear how pure propolis, as found in bee hives, can impact mites or whether it also affects the transmission of viruses. In this study, we investigated the effect of propolis on varroa mites and the prevalence of varroa transmitted viruses. In a laboratory experiment, we exposed varroa mites to a propolis environment and recorded their survival. We additionally monitored total resin intake and varroa infestation loads in 38 honey bee colonies in the field, and experimentally modified propolis quantities within hives by either adding or removing propolis from additional ten colonies. Bees were subsequently screened for the presence of deformed wing virus (DWV) and sacbrood virus (SBV). We found no correlation between total resin intake and varroa infestation, but bees from hives with experimentally enriched propolis quantities had significantly lower viral loads. Moreover, mites exposed to a propolis atmosphere died slightly faster than mites not exposed to propolis. We thus suggest that resins can indirectly affect virus transmission via direct inhibitory effects on varroa mites.

O9 - Allergenic fungi quantified under organic and integrated farming

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Fungi are an important source for allergies, following pollen as 2nd most significant aero-allergen producers outdoors. Agricultural landscapes are a main outdoor environment. Their composition regarding the growth of potential allergen producing saprotrophic fungi therefore influences our daily lives.

Here, we exemplify a risk study on the quantity of known allergenic fungi growing on wheat fields under different management. Additionally, we demonstrate a monitoring tool for assessment of allergenic fungi in their outdoor environments.

Wheat litter, plant-soil congeries and bulk soil were sampled following harvest and from organically or integrated farmed plots (Scheyern Research Facility near Munich) managed under defined conditions for more than 20 years. Frequencies of the most relevant allergenic fungal species were measured via a quantitative PCR workflow we established for the comparative use with different environmental materials, i.e. soil, plant litter, mixtures. These estimations were complemented by a cultivation approach of more than 400 fungi actively growing on the sample material.

Our results revealed a greater influence of inter-field variation on the abundance of potentially allergenic fungi rather than the management system.

Quantitative monitoring of potentially allergenic fungi via the qPCR workflow shown here is resource efficient and allows for a high observation detail. Applying it on different spatial and temporal scales may prove as a useful tool for allergy research (e.g. its development, avoidance), agriculture (e.g. growth of pathogens) and general ecology of saprobes fungi.

O10 - Studies on biodiversity recovery following management of the invasive aquatic weed *Pistia stratiotes* L. (Araceae) in pools

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Mats of the invasive aquatic plant, water lettuce, *Pistia stratiotes* L. (Araceae) can affect water resource utilization as well impact biodiversity. However, this weed can be effectively controlled using manual removal, in small infestations, herbicide application and biological control. Herbicide applications offer the quickest solution, but there are concerns about changes in water quality as the mat decays quickly. We set out to evaluate the impact of *P. stratiotes* on benthic biodiversity and more importantly how it recovers once the weed has been controlled. The one year lab-experiment clearly demonstrated that the water lettuce weed had a significant impact on the recruitment of macro-invertebrates to the artificial substrates, and water lettuce contributed to the reduction of oxygen in the water and consequent reduction of macro-invertebrate abundance and diversity. The biodiversity recovered at the same time in the pools containing water lettuce controlled by *Neohydrionomus affinis* and water lettuce controlled by herbicide, but richness and diversity of macro-invertebrates was higher in the water lettuce controlled by *N. affinis* during the first sampling occasion compared to the water lettuce in pools controlled by herbicide, where macro-invertebrates increased only when DO levels recovered after water lettuce mat decay. The number of taxa recorded in this study is an indication of the significance of macro-invertebrates in an aquatic environment. This therefore emphasizes the need for more research efforts into macrophyte and macro-invertebrate associations in the aquatic system to better understand the implications of habitat modification arising from human activities. It will also enable us to be better equipped with a more appropriate ecological understanding for aquatic resources management.

P1 - Degradation of rivers in Kosovo

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After 1999 many operators have degraded riverbeds, disturbing phenomenon with long-term consequences for the ecosystem of the rivers. In the last decades, without bypassing the previous period, rivers of our territory have been posed to a growing pressure from human activities and economic development, which in most cases is expressed not conform to environmental sustainable development and long-term consequences. Most of the riverbeds are degraded in the western part of Kosovo. The aim of the study was to identify the degraded surfaces of riverbeds of the 15 most endangered rivers in the four river-basins, the risk assessment and environmental status from river degradation and ecosystem degradation, flows and landscape.

The methodology used in the study was a comparative method to various studies, the research of 15 major rivers in the country. All direct evidence of degraded rivers, usage of GPS coordinates for the definition, use ortophotos in 2009 and 2012 as comparative models and assessment environmental impact on the river ecosystem. Since 1999 and until 2009 rivers are degraded with a total area 1004.77 ha by 2012, while degradation is increased with a total area of 1219.23 ha.

A quite rich biodiversity of our rivers is often attacked because of the human factor interventions.

Conclusions derived from the study have shown that the rivers of the White Drin Basin or the western part of Kosovo has the biggest degradation due to the socio-economic impact, the existence of the largest rivers, big amounts of flows with the aggregates and surface most appropriate for exploitation. Degradation of rivers in this basin have resulted 1165.73 ha.

While Ibri basin, Morava of Binca and Lepenc extending the country's Northeastern part, study showed that degradation of rivers is smaller with 53.50 ha. This has impacted due to smaller rivers, geographical position not suitable for exploitation and smaller aggregate flow. The effects of degradation are identified with potential damages caused by the extraction of inert materials as; create new aquatic channels and disorder of natural river flow, opening numerous holes along the course that pass over 10 m depth, flow diversion, increasing the risk of soil erosion, reduction of substrate stability, opening new trails on the rivers and natural changing of the river ecosystem, flora and fauna.

P2 - Will current agricultural practice require adaptation under the conditions of regional climate change impact?

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The NaLaMa-nT research consortium, co-ordinated by the University of Göttingen, analyses implications of climate change for different ecosystem types in Northern Germany. As a contribution to this network, the Chair for Landscape Ecology (University of Vechta) studied, how long-term trends in temperature increase as discussed in the context of regional implications of global climate change would affect soil nutrient and water budgets in agricultural ecosystems in Northern Germany.

For this purpose, soil data, crop rotation and crop management data of the reference period 1991 – 2010 were compiled and combined with climate scenario data covering a period of 60 years into the future. The Water and Substance Simulation Model WASMOD was applied used to estimate, whether soil water, carbon and nitrogen budgets would be affected by temperature increase and alteration in rainfall pattern as projected by current expectations of climate developments for Northern Germany.

We present results for the county of Uelzen (Lower Saxony). It is shown, that for scenarios with highest level of potential temperature increase modifications of current agricultural management might likely be required, however, for most of the soil types and for moderate temperature increase, it seems that the impact could be handled within the established agricultural management practice.

END OF SESSION 24

Session 25 - Prospective benefits of knowledge transfer in ecology

CHAIRS: JULIANE STECKEL, CLAAS-THIDO PFAFF, SOPHIA RATCLIFFE

O1 - Teaching research data management across disciplines and different graduation levels

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In fields like Ecology, Biology or Geoscience research relies fundamentally on data gathered in the field or the laboratory. However, according to Reichman et al. (2011, DOI:10.1126/science.1197962) “...less than 1% of the ecological data collected is accessible after publication of associated results.” Although this estimated number may have increased slightly by now, effective research data management is still not an integral part of the science workflow for many researchers.

In this presentation we will focus on activities towards education and training of students and young scientists. We would like to share and discuss our experiences in developing and implementing courses on research data management. We believe that a portfolio of different courses addressing different target groups is needed to raise awareness for the need of data management and to develop the appropriate skills to use and develop research data management tools.

In order to create a general awareness on data management issues as early as possible we develop single (1.5 hours) lectures for B.Sc. and M.Sc. students, which can be easily integrated into existing curricula.

Besides educating students in ecology or related disciplines it is also important to train computer science students on research data management. Here we will develop an entire, semester-long module as part of the Computational and Data Science Master at FSU.

We have developed a 1-day workshop for PhD students “Research data management - make your data count!” which will be run for the first time in June. With more data management software becoming available, there is a need to offer hands-on training courses on these tools. For example, there have been a number of practical training courses for the Biodiversity Exploratories Information System. We will continue this type of course also for the new BExIS 2 platform and will extend them to include online courses.

These activities are aligned with similar activities in the GFBio project. All course materials will be made available under a Creative Commons License. These activities are funded by the German Research Foundation (DFG) and in part by the Friedrich-Schiller-University Jena.

O2 - Streamlining material- and data flow within the German Barcode of Life Project, GBOL

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The material- and dataflow constitutes a crucial point within the German Barcode of Life Project (GBOL). Within this large-scaled project, a network of interactions span the material- and dataflow, from collecting the physical specimen, to laboratory processing and finally providing the barcode sequence and metadata. The underlying data system allows tracking the sampled material from the tissue sample to the final barcode sequence and back to the original specimen from an exact geographic location in Germany. The web site 'www.bolgermany.de' provides a portal for the taxonomic experts collaborating with GBOL to check which species and regions still need to be sampled, to order collecting material, to enter and update associated metadata for the collected specimen, and to submit the specimen to GBOL. The Diversity Workbench framework (www.diversityworkbench.net) functions as central data repository for the GBOL project, stores laboratory data and is further extended to provide the possibility for sharing data among the web portal, the taxon coordinators and curators at the involved institutions. The GBOL consortium, composed mostly of natural history collections, archive and procure the voucher material, house the laboratories and workers as well as various external data services. These provide additional information relevant for the workflow and disseminate the results back to the public. Images are archived and disseminated via the morphological data repository MorphDBase (www.morphdbase.de).

O3 - Data Quality Management Workflow inBExIS

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Experiment data is prone to containing errors; therefore, data quality management (DQM) is an important integral part of the Biodiversity Exploratories Information System (BExIS) - the application used for managing the Biodiversity Exploratories projects data. Of recent, BExIS is being redesigned to be modular, scalable and extendable, and in the new version, a DQM framework module is being developed. Within it, a user can specify DQM criteria on (groups of) variables at data structure design time. Such criteria include integrity constraints, data types, regex patterns, series definition, variable dependencies, complex business rules, e.g., condition-based patterns, and domain value ranges. In addition, users will be able to specify other variables/datasets which are related to a variable/dataset being created, and

thresholds for indicating dataset/variable/tuple completeness and redundancy. Based on some of the DQM criteria specified, a user will be able to download Microsoft Excel templates with macros for performing a guided data entry and validation before dataset upload. At upload time, the dataset will be validated against some of the user-specified DQM criteria. Afterwards, dataset auditing will be carried out as a batch process. Data profiling which generates a description of the components of the dataset using various statistical metrics will be carried out as the first part of data auditing. The other part consists of several forms of data analytics and mining procedures using information such as the related dataset/variable provided at data structure design-time. Some of the analysis done will include outlier detection, redundancy analysis (using absolute or fuzzy matching techniques), text based analytics (for detecting, e.g., spelling errors, groups of misspelled terms, cryptic names etc.). Furthermore, the data structure will also be examined to determine, e.g., non-atomic columns (columns containing information that can be separated into more than one columns). A report based on the data profiling statistics and the probable errors based on the data analytics will then be sent to the data owner. Finally, the correction and enrichment component will assist the data owners to (mass-) correct their dataset based on the report. This component also consists of tools for data enrichment e.g., link to Catalogue of Life for species datasets.

O4 - TRY - a global data portal for plant traits

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Plant traits are fundamental for understanding and predicting vegetation responses to global changes, and they provide a promising basis towards a more quantitative and predictive approach to ecology and biodiversity research. Therefore plant traits are highlighted by GEO BON as Essential Biodiversity Variables and by GBIF as relevant information in addition to species occurrence data. At the same time plant trait data are highly heterogeneous, exhibit a low degree of standardization and are linked and interdependent at various levels of biological organization: tissue, organ, plant and population. Therefore, they often require ancillary data for interpretation, including descriptors of the biotic and abiotic environment, methods and taxonomic relationships.

The TRY initiative, a global network of more than 600 researchers, has so far integrated 220 major plant trait databases, with about 5 million trait entries for 1.000 traits and 80.000 plant species. The TRY website offers data provider defined access (public/restricted) for customized data requests.

TRY is based on an opportunistic sampling scheme and thus results in a sparse data matrix. We currently explore to which extend the interdependencies of plant traits in combination with the unprecedented data coverage allow for inference of missing trait values and extrapolation of the data.

The compilation of terms and data in the context of TRY and the involvement of the scientific community provide the basis for an agreed vocabulary and thesaurus of plant traits. The consolidation of this domain offers the opportunity for a network of plant trait databases and semantic integration of plant traits into environmentally related biological data in general.

O5 - The EML metadata package for R

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A large amount of ecological data is gathered each year by researchers worldwide striving to enhance the knowledge on our ecosystems. With a growing awareness on the value of data various online data management platforms have been developed to store and share ecological data (e.g. BEFdata and BExIS). These platforms offer access to the diverse landscape of data present in ecology which is reflected in the variety of methods used, the diverging naming of variables and the complexity of data structures. Using many of these data together offers the potential to answer questions in ecology on a much broader temporal and spatial scale. To fully utilize the potential of available data a sound representation of standardized metadata is required. We present the Ecological Metadata Language (EML) package for R with offers an innovative way of creating standardized metadata for your research data right from within R. We highlight the functionality of the package using an example workflow that shows how to read, create, validate and upload data and metadata to online repositories to make your data more visible and citable.

O6 - The Diversity Workbench - a research data management platform as part of the GFBio infrastructure

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The Diversity Workbench (DWB; www.diversityworkbench.net) is a virtual environment and platform for the management and analysis of research data. The database framework is appropriate for biology and geodiversity research and facilitates the processing of molecular and ecological analysis, observation and collection data. The DWB offers a set of databases and tools for data import, maintenance and storage.

GFBio ('German Federation for the Curation of Biological Data') is a DFG-funded data infrastructure project. It brings together national key players providing environmentally related biological data and services. GFBio will cover the full life cycle of research data. In this context the DWB databases support a number of services for (a) data gathering in the field and lab, for (b) quality assurance, (c) data deposition and (d) data preservation. On the one hand, DWB installations may be run locally and on the other hand be used via intranet or internet. Four variants of the DWB installations can be distinguished. Its interoperability, flexibility and scalability are the result of a conceptual design relying on data domains. A network with more than 10 relational database components makes the management system appropriate for individual researchers, for small and large research groups and for institutional data centers.

Extended DWB installations at data repositories like those of Germany's major natural history collections have mechanisms included to process data for data publication and preservation. The services also include those developed within GFBio.

O7 - Making biodiversity data publicly available - a case study using the Jena Experiment

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There is a growing consensus that scientific data should be made publicly available. A number of public data repositories have been created and an increasing number of journals demand of authors to deposit their data in such repositories. Nevertheless, the fraction of scientific data deposited in such repositories is still very small. An alternative to transfer data to a public repository is to make data publicly available from within the project database of collaborative research groups. Many of these research groups have implemented project-specific databases to make data available for cooperation within the research consortium. In doing so they have overcome several difficulties including convincing scientists to deposit their data timely into the database and developing a data use and publication policy.

The Jena Experiment (JE) is one of the longest running biodiversity experiments in Europe and encompasses an enormous variety of heterogenic biological data, which makes data management a particularly challenging problem. The database used has been through a transition from a common data storage platform to a functional information system. In 2008, cooperation with the Biodiversity Exploratories project and its information system – BEXIS was initiated. Later a web-based user interface, variable-specific meta-data and a JE data use and publication policy were adopted.

In 2014, up to 3000 datasets (each a variable measured in a specific experiment in response to plant diversity) will be made publicly available through the JE Information System by a role-controlling approach. This approach made adjustments to the data use and publication policy and access rights necessary that can serve as a case study for other information systems. All prerequisites have been implemented and several test datasets are already made available on JE system. After registration, not only JE members but also external members have access to these data. Their long term availability beyond the JE project (and thus the database) will be ensured by transfer of data from BEXIS instances to long-term archives (e.g. GFBio: <http://www.gfbio.org/>).

O8 - Data publication - efficiently linking scientific data and publications

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To answer global questions like climate change or biodiversity loss, it is necessary to share and integrate the increasing amount of data across disciplines in ecosystem research. This – besides efficient usability of data - requires first and foremost a new transparency of scientific work and thus cultural change. Recent surveys have shown the willingness of researchers to share their data but also their concerns. The concept of data publishing is an incentive for scientists to share their data, promoting transparency and encouraging a new culture of data use. Data publication can be similar to the conventional publication of articles in journals, including online submission, quality checks, peer-review, editorial decisions, and an equivalent of 'page proofs'. In fact, data storage in open access databases is getting increasingly important and is even mandatory for the acceptance of peer-reviewed publications in specific journals. Therefore, data publication services need to be integrated into the traditional science publication process. This requires collaborations with science publishers as well as services, and thus the resulting linkage of data and articles can significantly enhance data discovery. PANGAEA, Data Publisher for Earth & Environmental Science, has already established such editorial workflows for data publishing and long-term archiving including the registration of persistent digital objects identifiers (DOIs) and data citations. The latter components are the keys to a rapidly expanding suite of services that contribute to the authors' bibliometrics and impact factors and offer improved data discovery, dissemination and re-use. Therefore, individual scientists as well as the scientific community do benefit from data publications. This is also recognized and supported from various stakeholders such as the ICSU World Data System, the Global Biodiversity Information Facility, the Research Data Alliance and the European Commission.

P1 - DiversityMobile - a smartphone application for monitoring ecological and biodiversity data in the field

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As an alternative to pen, writing pad, GPS receiver, camera, video and audio recorder, DiversityMobile is an application for smartphones, designed for scientists monitoring ecological and biodiversity data in the field (www.diversitymobile.net). It is implemented for smartphones running Windows Phone versions 7.5 to 8 and uses GPS functionality as well as digital imagery. The application is freely available at the Windows Phone Marketplace under <http://www.windowsphone.com/de-de/store/app/diversitymobile/54215bc5-8640-40df-917d-ae718b7542f3> and is best deployable as part of the modularised Diversity Workbench (DWB) framework.

Features are:

- working offline in the field, including the availability of vocabularies, taxon lists and topographic maps
- recording data and metadata from observations, reference vouchers and field analysis (measurements, countings, observation categories, etc.)
- gathering and linking multimedia files and their relations to database entries
- recording GPS coordinates
- recording associations between organisms

At the end of the field campaign and when being connected to the Internet again, all metadata, GPS data and multimedia files can be uploaded easily onto DWB data repository via selecting simply one button. Thereby uploads keep multimedia data and database entries linked to each other. By using the DWB, subsequent quality control and management of uploaded data is possible. In addition, data can be published via GBIF and other data portals.

END OF SESSION 25

Session 26 - Statistics in ecology and environment

CHAIRS: WOLFGANG FALK, HOOMAN LATIFI, ARNE NOTHDURFT

O1 - A naive Bayes model to describe natural forest ground vegetation by waveform LiDAR metrics

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Though understory layer in forest (including the herbal species) contributes minimally to the total biomass available within the stands, it is one of the most important representatives of species richness as well as a widely-accepted criterion for characterizing plant communities. Furthermore, the ground vegetation is a main source of nutrients used as forage by ungulate animals, as well as a potential provider of contributing fuel to forest fire hazard. As a result of being masked by the overstory species, the most types of remote sensing data are basically unable to penetrate down to the forest ground layer, which in turn hinders their use for studying the forest surface material. We applied 3D understory metrics from a waveform Light Detection and Ranging (LiDAR) survey to describe the dominant cover type classes of ground vegetation within a portion of Bavarian Forest National Park (BFNP) in Germany. We assumed the independence arbitrarily-selected input predictors (e.g. vertical distribution ratio, understory height, shrub and cover for all laser returns). The conditional posterior probabilities were computed by a Naïve Bayes classifier incorporating a Laplace smoothing. The computed posterior was used for an area-based prediction of ground vegetation cover. As compared to a nonparametric Random Forest classifier, the latter approach showed yet higher performances by classifying the herbal layer. The Naive Bayes classifier showed yet advantages by classifying the shrub layer. The prediction maps made by Random Forest showed a more realistic reflection of dissimilarities across the test site, whereas the Naive Bayes showed biases by tending towards the extreme cover classes. It, however, provided a better representation of forest gaps. The results show that also older reference data on cover type dominance could be used for classification. In addition, data of more detailed surveys, that include the dominance of individual plants, can also be used under the condition that it is nearly interval scaled.

Ongoing experiments will presumably unveil the use of naive Bayes rule for describing ground forest vegetation under its more or less strict underlying assumptions.

O2 - A new automated protocol to define site factor classes and ecological species groups for bioindication

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There is a long tradition in applied ecology to use plant communities as integrative indicators of environmental conditions. Particularly edaphic characteristics like soil moisture, soil reaction and nutrient supply are commonly estimated by means of expert systems like Ellenberg Indicator Values (EIV) or by the combination of ecological species groups. While the calculation of mean EIV is mathematically questionable, requires full species lists and can hardly be achieved directly in the field, ecological species groups allow a more rapid on-site mapping of site factor classes like nutrient or water levels. So far, ecological species groups and site factor classes have been derived from manual table work with large and representative vegetation datasets and complementary site measurements.

We developed an automated protocol to define site factor classes and ecological species groups for a given environmental gradient. The procedure requires a sufficient dataset of vegetation plots including measurements of the site factor of interest and is based on a simple ordination of the plots along the rank-ordered factor measurements. Every possible split of the gradient into factor classes is evaluated by means of a multiple group indicator species analysis, modified from De Cáceres et al. (2010) and those splits are saved that reveal the highest sum of significant indicator values, i.e. the best floristic separation of factor classes. The optimal number of splits is evaluated by a post-hoc process that takes into account the floristic distinctiveness of the factor classes, i.e. the chance to separate adjacent factor classes by means of the occurrence or lack of ecological species groups.

De Cáceres, M., Legendre, P., Moretti, M. 2010. Improving indicator species analysis by combining groups of sites. *Oikos* 119(10): 1674-1684.

O3 - A new approach to measuring functional trait richness in a multivariate context

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Quantifying functional trait diversity is useful for understanding ecosystem processes and functioning. Functional diversity is often partitioned into three components, richness, evenness, and divergence. We propose a novel index for assessing multivariate richness that overcomes some limitations of previous indices. We propose uMVR as a measure of the filled trait space, and sMVR as the amount of filled trait space divided by the trait space range. Like convex hull

approaches, both uMVR and sMVR can be partitioned into alpha and beta components when used across sites, and the beta component can be further partitioned into turnover and “nestedness-resultant dissimilarity”. Unlike convex hull approaches, uMVR can be used with existing evenness measures as it can incorporate species’ abundances. We present the concepts these indices are based on and give examples of their use. The new indices are compared to the existing indices on the basis of criteria specified in the literature and one novel criterion. We test & evaluate the new measure using simulated data and field data.

O4 - The realized niche breadth of vascular plants across the European Alps

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Habitat specialists are species with a limited realized niche breadth and are thus considered to be more prone to extinction than habitat generalists under changing environmental conditions. Although several metrics exist to measure species realized niche breadth and thus habitat specialization, no studies so far has tested for correlations among these different metrics and how each of them relates to species ecological traits. By focusing on 1330 non-woody plant species occurring in the European Alps, we aim at studying correlations between three different metrics of species realized niche breadth: (i) a ‘locally’ derived beta-diversity metric, which increases if the focal species co-occurs with more species; (ii) a ‘regionally’ derived abiotic metric based on occurrence data of the focal species within the entire European Alps; and (iii) a ‘globally’ derived abiotic metric based on the global distribution of the focal species. We furthermore explored the relationships between these three metrics of species realized niche breadth and selected species traits. To derive each of the three metrics of species realized niche breadth, we used species co-occurrence data from the Alps Vegetation Database, bioclimatic

data from WorldClim and global distribution maps digitized from several sources. Species traits and life-strategies were derived from the TRY database and Flora Indicativa. We found a moderate correlation between the two locally derived niche breadth metrics (Kendall's $\tau = 0.2885$) whereas both metrics showed only a weak correlation with the globally derived niche breadth metric (local beta-diversity metric: $\tau = 0.0754$; local abiotic metric: $\tau = 0.1471$). Irrespective of the metric used, species life history traits and species dispersal traits only weakly explained species realized niche breadth, whereas Grime's life strategies best explained variation in species realized niche breadth. We conclude that current metrics to measure species realized niche breadth should be handled with caution.

O5 - A unified framework to combine disparate data types in species distribution modelling

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The purpose of species distribution models is to use data on observations of species to infer their full distributions, and the drivers of their distributions. But the data itself can come from a variety of sources, from planned surveys to citizen science records and expert range maps. If we are to use this data efficiently, we should be able to combine the different types of data into a single model. Here I will describe a state space approach, modelling the actual distribution as a continuous intensity and developing observation models that are appropriate to the data.

We will use data from the Map of Life project (www.mol.org) to demonstrate how this approach can be applied to point counts, species lists from nature reserves, and expert range maps, and show how the data are combined, and how we can incorporate effects of spatial biases in collection.

O6 - Risk and opportunity - combining two management strategies in Bavaria

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Forestry is an important land use form in Bavaria covering one third of the state and forests serve to fulfill ecosystem functions. Forest management aims to balance the differing demands and at the same time has to deal with threats e.g. by a warming climate. The presented approach aims to combine two management topics: The description and mapping of site productivity and the description and mapping of a cultivation risk. The statistical modeling used to approach these perspectives is based on generalized additive models. Site productivity is in the focus of forestry since a long time e.g. in form of yield tables and cultivation risk

has received high attention lately in the discussion about adaptation of forest to climate change. Forest management under climate change has to combine both perspectives: risk and opportunity.

P1 - Do we stop analytical thinking halfway? Uncertainty communication problems are at the heart of scientific activities

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While proper communication of various scientific uncertainties to public is often a concern, serious neglect of uncertainty exists just at the very basic level of scientific activity: analysis of results coming from experiments and observations. This applies to many domains of research, including ecology. The prevailing, often harshly criticized paradigm of Null Hypothesis Significance Testing (NHST), described sometimes as "putting our results on significance altar", may be seen as a way of hiding statistical uncertainties and, as a side effect, introducing biases. Critics of NHST have proposed focusing on other facets and methods of data analysis.

We suggest that, no matter what specific ways of analysis are followed, in most cases they end at the point when maximally sharp picture is obtained. As a result, existing uncertainties remain poorly visible, indications of them are treated only as an additional information, and they hardly attract serious consideration. In this sense, analysis is often stopped halfway, in spite of the fact that estimates of uncertainty are essential for arriving at statements bearing sufficient degree of confidence.

We focus mainly on the relationship between NHST and interval estimation to reveal statistical uncertainties hidden beneath the smooth surface provided by NHST-based analyses. We point to possible consequences of NHST-reliance: prevalence of false discoveries, overestimation of some effects and nullification of others, poorly justified scientific debates and controversies, diversion of attention from quantitative questions to questions about statistical significance, distant from subject-matter importance. The issue of "irreplicability crisis" in science is also considered from this perspective.

A quick look at some other alternatives proposed to NHST also reveals ubiquitous propensity to obtain sharp pictures of the studied phenomena. In contrast, we claim that stronger focus on uncertainty quantification is needed.

END OF SESSION 26

Session 27 - Advances in technology and modelling

CHAIRS: CHRISTINE JUNG-DAHLKE, PATRICK E. OSBORNE

O1 - Projected Future Vegetation Changes in East Africa: Towards a Scientific Basis for Conservation

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Understanding the temporal and spatial evolution and response of ecosystem dynamics under changing climate is of vital importance for nature conservation and ecosystem management efforts. This applies especially to regions like East Africa, which has one of the fastest growing populations in the world and hosts a broad variety of ecosystems including globally important biodiversity hotspots. One way to achieve such an understanding is to study past, present and future environmental changes with predictive tools such as dynamic vegetation models (DVMs). Here, we simulated the distribution and composition of East Africa's vegetation with an individual-based DVM, LPJ-GUESS for the period 1961-2100. The simulated modern biomes are in agreement with observational data such as vegetation maps and pollen records. For model validation, we also applied the model under a climate change scenario from the past (6 kyr BP) which corresponds well with the available fossil pollen data. For future projections, we used the outputs of 8 Global Climate Models which were downscaled by Regional Climate Models with different initial conditions. Our results clearly show (i) that sensitivities of different biomes of East Africa towards predicted climate change differ strongly, and (ii) specifics of climatic changes such as the timing of precipitation can significantly impact biome responses. Although LPJ-GUESS does not include an anthropogenic influence by land-use or nutrient input, the simulated dynamics of the vegetation under different realizations of possible future climate provides a solid scientific basis for a proactive conservation of the vulnerable biodiversity and an adaptive management of the limited resources in the region.

O2 - Modeling of optimal annual routines to infer migration timing in white stork

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Migratory animals most often follow strict annual cycles that are determined by seasonal environments. Activities are scheduled in a regular way over the year. Birds like the white stork migrate, breed, rear young, molt and overwinter within the course of one year. Here, we seek to understand the optimal timing of these key events over the annual cycle of white storks and the factors determining these

behavioural patterns. We implemented an annual routine model for white storks to find the optimal behavioural strategy that maximizes the lifetime reproductive fitness of individuals. The model uses stochastic dynamic programming to derive the optimal behavioural strategy under relevant constraints such as the energy level, health status, breeding status or age of the individual. Once the optimal annual routine is identified, cohorts of individuals following the optimal strategy can be simulated forward in time. Various scenarios with different degrees of seasonality in the environment are analysed and the results are compared to telemetry data. Using the model, the relationships between migration, survival and reproduction are examined on the individual but also on the population level, taking into account stochastic environmental conditions. The model helps in understanding the evolution of migratory flyways in white storks and the behavioural responses to their environment which is a prerequisite for the conservation of this migratory bird.

O3 - How to overcome the rare species modelling paradox? A test on 107 species of conservation concern

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Reliability of species distribution models (SDMs) has been improved with the introduction of recent machine-learning methods (e.g., Maxent, Boosted Regression Trees) and consensus modelling using weighted averages of single SDMs (e.g., as implemented in Biomod). SDMs have thus become a standard tool in ecology and applied conservation biology. Modelling the distribution of rare and threatened species, however, is still a challenge although models of such species could be very useful for applied issues in nature conservation. The main problem for modelling such species is the usually low number of occurrences. Only few available occurrences with many predictor variables easily lead to model-overfitting and imprecise estimations of coefficients. 'Ensemble bivariate models' (EBMs), a new strategy to overcome this so-called 'rare species modelling paradox', were successfully tested for a single species so far (Lomba, Pellissier, Randin, Vicente, Moreira, et al., 2010). We aimed here to test this new strategy on 107 rare and undersampled vascular plant species of conservation concern in Switzerland to find out if and when EBMs outperform traditional SDMs. Three commonly used modelling techniques and their ensemble forecast were used to compare EBMs with standard SDMs. We could show that EBMs perform significantly better than standard SDMs and that this effect is more pronounced the rarer the species are. We further showed that EBMs improved the reliability of SDMs especially for rare species and thus help to overcome the 'rare species modelling paradox'.

Lomba, A., Pellissier, L., Randin, C. F., Vicente, J., Moreira, F., et al. (2010). Overcoming the rare species modelling paradox: A novel hierarchical framework applied to an Iberian endemic plant. *Biological Conservation*, 143, 2647–2657.

O4 - New visualisation tools to assess extrapolation behaviour of species distribution models and map novel environments

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Statistical species distribution models (SDM) have become a prominent tool in conservation biogeography and global change research. They relate species occurrence records to environment and fitted relationships can be used to make predictions in space and time. Often, the species-environment relationships are complex with many environmental axes making it difficult to fully explore model extrapolation behaviour. Here, we present a new visualisation tool, inflated response curves, to assess multivariate response shapes. Moreover, we introduce a simple tool to find novel environmental combinations in data sets that can be used to indicate where extrapolation has occurred. These tools help to explore cases that were previously difficult to visualize and may improve confidence in models and predictions.

O5 - Can We Use Functional Types to Predict Responses of Birds to Changes in African Savannas? An Individual-Based Modelling Approach

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Understanding the underlying processes in occurrence, abundance and diversity of species is important to predict future patterns of species diversity in changing environments. In arid and semi-arid savannas, heavy land use impacts and changes in climate substantially affect habitat composition. In particular, pristine savannas areas dominated by grass vegetation can turn into areas dominated by woody plants. This transition in vegetation composition can lead to habitat loss and fragmentation affecting habitat suitability of animals.

To study these impacts on species there is a need for more generalized approaches instead of investigating each species by its own. We developed a generic individual-based and spatially-explicit model for savanna birds using a functional type approach to investigate which functional types are particularly sensitive to

modifications in habitat structure. The functional types are characterized by different traits such as the use of vegetation structures (i.e. for nesting, foraging, sheltering) and spatial scales (i.e. territory size, dispersal abilities), which are related to habitat quality and body mass. We tested artificial landscapes varying in shrub–grass ratios and clumping intensity of shrubs as well as different rainfall scenarios for body masses ranging up to 1000g.

Model result suggest that insectivorous and omnivorous birds are more sensitive to clumping intensity of shrubs while herbivorous and carnivorous birds are affected by the total amount of grasses. A higher inter-annual variability in rainfall resulting in dry years in series could lead to a dramatically decrease in habitat quality and thus to the extinction of functional types in suboptimal landscapes. An increase in woody vegetation caused by land use (mis)management and a decrease in habitat quality due to on-going climate change will endanger all tested functional types, partly depending on the clumping intensity of encroached patches.

O6 - Individual-based modelling to study habitat connectivity under future landscape management scenarios

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Using RangeShifter, a novel modelling platform which combines population dynamics with individual-based dispersal behaviour, this study tests a number of landscape-scale conservation actions, and their impact on biodiversity. Species in the model are parameterised with trait-space data broadly representative of real dispersal and life-history attributes. Future landscapes have been created to represent the spatial application of management actions such as habitat improvement, restoration, creation and landscape matrix modifications. Previous studies on landscape management have often simulated instantaneous impacts on biodiversity when management decisions are made. Empirical data on the time-lag between the action and the realisation of biodiversity benefits are used to generate more realistic representations of landscape transitions through time. The implications of the spatial location of these actions will be tested, i.e. the biodiversity benefits of creating new habitat adjacent to existing habitat, or creating it randomly within the landscape. Model results should provide guidance on the best management practices for landscape-scale conservation; for example, testing the relative biodiversity benefits of habitat creation versus improvement of existing habitat. This study will provide useful information to underpin the current shift towards landscape-scale conservation and climate change adaptation.

O7 - Modelling phenology in *Populus* under variable climatic conditions

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Populus nigra is an endangered species that has been co-occurring for over 100 years with planted *P. deltoides* × *P. nigra* hybrids (*P. × canadensis*) in the landscape of Germany. While crossings have been observed in both directions, this has not yet led to a coalescence into one species, which is suspected originate from the exiguity of overlapping flowering time. However, increasing flowering overlap has been observed between *P. nigra* and the hybrids after extremely long winters. These observations correspond to the current hypothesis that phenological behavior is strongly linked to environmental conditions and consequently subject to climate change. Since short rotation plantations of manifold poplar hybrids are about to be established in great scales in Germany, *P. nigra* populations are potentially facing even further endangerment by introgression.

To estimate the introgression between *P. nigra* and its hybrid species in the face of climate change, we built an agent-based model in NetLogo focusing on their flowering behavior.

Agents in our model are equipped with general features like age and size, while their species status is determined by the composition of species specific markers. Depending on these markers, agents form several species specific traits connected to abiotic environmental conditions such as water and soil conditions, introducing competition for resources. The key feature, however, is a set of inheritable behavioral traits that control the time frames of pollen and seed dispersal. As observed in the flowering phenology of *P. × canadensis* populations, hybrid agents display flowering behavior that is intermediate between both parental species.

Using agents with these traits, the model is intended to simulate gene flow between species over generations, leading to F2-hybridization and back crossing, allowing an assessment of the increased risk of introgression in the present *Populus* populations.

O8 - Bayesian Inference - Integration of citizen science for estimating posterior probability

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Application of Bayesian inference has become of increasing interest to ecology. It can incorporate existing knowledge about a species' preferences for habitats as prior and its distribution information in a landscape as likelihood. The remarkable point of this statistical method is that probability is based on an individual's degree

of belief in the likelihood of an event and that the probability of encountering the species in the landscape, for example, can be iteratively updated using newly acquired datasets. Over the years of ecological studies, knowledge of habitat preferences and ecologically-relevant land use/cover is collated and general relationship between them is widely recognized. In addition to utilization of existing knowledge, we employed species observations gathered from citizen science in Wetterau district in state of Hesse, Germany. Heterogeneity in the large quantity of datasets across space and time is smoothed out through thorough data mining process, and observed species were classified into groups based on life history traits. Within the constraints inherent in citizen science, we estimated the posterior probability of encountering a species group given a certain landscape characterized by ecological perspective, and examined ecological relevance of characterized landscape to organisms. The overarching goal of our study is to develop a methodology for effective utilization of citizen science and providing prior information applicable for next iterations in a similar landscape.

P1 - Modelling Hybridization in Neotropical fig species

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Fig species (*Ficus*, Moraceae) and fig wasps (Chalcidoidea, Hymenoptera) are involved in a tight species-specific mutualism. Each of the ~ 750 fig species has its specific pollinator species.

Species specific pollination is enforced by a number of co-adaptations: both, the species specific scent emitted during the receptive phase and characteristics of the surface of the syconia attract only specific pollinators and, the shapes and sizes of ostiole permits access only to fig wasps with a certain body size. However, recent phylogenetic studies imply that there are host switches as many fig species are genetically not well resolved and phylogenetic trees of figs and wasps are not congruent. This indicates that hybridization is not as rare as assumed before and eventually plays an important role for speciation. Especially in areas where two closely related fig species occur, hybridization might happen more frequently than expected.

In our model, we reconstructed the mutualistic system of figs and fig wasps in order to determine which parameters influence the frequency of hybridization in figs. The chosen tool for modelling is NetLogo, an agent-based programming language and integrated modelling environment. We created a defined area with two fig species and their respective pollinating fig wasp species that implement observed real-world characteristics of figs and fig wasps. The two fig species differ in their attractiveness to the wasp species. Environmental factors such as wind speed and direction will also be implemented as they might significantly influence dispersal range, and thus hybridization rate. The model is calibrated with data from

the Barro Colorado Nature Monument, Panama. An appropriate time frame will be simulated to explore the hybridization performances in fig species.

In general our model tends to assume lower hybridization rates than stated in the latest publications. While further studies are required, first results will be presented and discussed.

END OF SESSION 27

Session 28 - Remote Sensing

CHAIRS: PEDRO J. LEITÃO, SEBASTIAN SCHMIDTLEIN, HANNES FEILHAUER

O1 - Determining vegetation resistance and resilience against climate anomalies on a global scale

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A change in average climate conditions combined with more severe and a higher frequency of climate disturbances are predicted for many parts of the world. These changes will affect vegetation health, with major economic, ecologic and climatological implications. Within this context, large scale assessment of ecosystem stability is crucial to quantify the sensitivity of ecosystems to environmental disturbances, but also to improve the understanding of the mechanisms that drive ecosystem response. A model that quantifies vegetation resistance and resilience at a global scale and takes into account climate variability is lacking so far. Therefore, this study aims to (i) present a standardised indicator of short term vegetation resilience and resistance to drought and temperature anomalies; and (ii) improve our understanding of vegetation resistance and resilience in drought sensitive areas by linking the developed vegetation stability metrics to the percentage tree, non-tree vegetation and bare ground cover on a global scale.

First, anomalous vegetation behaviour, quantified using Normalised Difference Vegetation Index (NDVI) anomalies, was modelled in function of past NDVI anomalies, an instantaneous drought indicator and temperature anomalies. Second, resistance and resilience metrics, extracted from the model, were related to the fraction of bare, non-tree vegetation and tree cover.

Comparison of the globally derived resilience and resistance metrics shows semi-arid areas with a low engineering resilience and a low resistance against drought, high latitudes areas with a low resistance to negative temperature anomalies, and a low resistance to positive temperature anomalies in the Sahel and Australia. In drought sensitive areas, resilience was optimal (i.e. the highest) for vegetation types with a bare cover between 3 and 20% for a tree cover between 5% and 15%.

O2 - Large wind-throw events affect biomass dynamics of Central Amazon forests

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Terra firme (i.e. upland) forests cover more than 60% of the Amazon basin. In these forests, trees (DBH ≥ 10 cm) account for $\sim 90\%$ of above ground biomass (AGB). Although tree mortality is dominated by single treefall events, large wind-throws are frequent in Central and Western Amazon promoting changes in species composition and diversity at the landscape scale. Monitoring the long-term effects of large wind-throws on biomass stocks is an important step to better understand and manage *terra firme* forests. We estimated tree mortality produced by three different large wind-throw events from the years 1987, 1997 and 2005, and assessed the long-term effect of wind-throws on biomass dynamics. Tree mortality was obtained from Landsat images by accounting for changes in the fraction of the non-photosynthetic-vegetation (ΔNPV), which is highly correlated with tree mortality ($r^2 = 0.8$). The changes in NPV caused by the wind-throws were assessed by applying Spectral Mixture Analyses (SMA) on images before and right after the wind-throw. We further combined tree mortality estimates with forest inventories to assess the effects of the three different large wind-throws on AGB recovery and genera composition over time. Over the chronosequence, mortality intensity explained a significant part of the AGB variation in plateaus and slopes. While areas under a low disturbance regime had AGB stocks similar to contiguous undisturbed forest, in highly disturbed areas the recovery of AGB lasted up to 24 years. Furthermore, the AGB fraction of light-demanding genera (high-disturbance specialists) decreased after 14 years, while the AGB of early-secondary genera (intermediate-disturbance specialists) increased between 14 and 24 years after the event. Our results not only demonstrate changes in the amount, but also in the quality of AGB affecting carbon cycling (e.g. via differences in life-span). The long time series and availability of Landsat images allows for effectively monitoring wind-throws events in *terra firme* forests. This can, in combination with repeated forest inventories, significantly improve our understanding of the effects of large natural disturbances and feedbacks on forest dynamics. This may be particularly important in case the return frequency of wind-throws increases due to climatic changes.

O3 - Tracking land-use changes from heterogeneous spatial data to monitor ecosystem services in the nature park Drömling

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Peatlands are important ecosystems for strongly specialized and endangered species but they are also hotspots of greenhouse gas (GHG) emissions when drained and used for agriculture and forestry. Detecting changes in land-use and land-use intensity at adequate resolutions as proxy for biodiversity (vegetation) and GHG emissions is an important prerequisite for assessing, and potentially monetizing multiple ecosystem services regained by peatland restoration. But frequently no consistent time series of land-use products are available.

We introduce a soft translation key to construct consistent times series of land-use at the nature park Drömling at a 0.01 ha resolution. Two different fine-grained spatial products were used to create a time series of 20 years. Furthermore, the land-use datasets were analyzed to test whether they are useful as proxies for groundwater table by using data of 148 groundwater dipwells partially operating since 1992.

The conversion from cropland to grassland and back seems to independent of the groundwater table, while other land use changes are accompanied by a change in the groundwater level. The information “wet” in spatial products can be useful, as well as detailed information of the groundwater table, but for making reliable statements both types of information are essential. Peatland rewetting in the nature park Drömling reduced 456 t year⁻¹ of CO₂ emissions, which is equivalent to 2.6% of CO₂ emissions from the peatland area.

It is impossible to distinguish between permanent and non-permanent land-use change on the diverse datasets. The groundwater table influences land-use and land-use intensity on organic soils in the nature park Drömling, so vegetation type can be used as proxy if available in good quality, but high uncertainty remains. Thus, detecting land-use change by fine-grained remotely sensed datasets could serve as a conservative method for monitoring biodiversity.

O4 - How much is enough? Habitat mapping and the need for hyper-resolution

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Knowledge of the spatial distribution of habitat types on landscapes scales is a valuable asset in effective resource and conservation management. Increasingly such information is derived using remote sensing based approaches. Yet, researchers frequently face the difficult decision which remote sensing data to acquire for a particular task. Apart from specific sensor to sensor comparisons there is no general understanding on how fundamental sensor characteristics such as spectral and spatial resolution interplay in determining mapping success.

We developed a general modelling framework for the identification of both sufficient and optimal sensor characteristics for a given modelling task with respect to both spectral and spatial resolution based on airborne hyperspectral imagery. The focus of our study lays on mapping habitat for different zoological communities in montane mixed forest stands in the Bavarian Forest national park, Germany alongside the determination of data requirements. Besides defining sensible limits in terms of spatial and spectral resolution the presented approach revealed some degree of complementarity between spatial and spectral resolution, where one can make up for shortcomings in the other.

Estimating the expected increase in model accuracy for transitioning from less suitable data to more suitable data can help inform on suitable sensor choice or sensor-setups as well as evaluating the expected return of purchasing better datasets. Finally, our approach also contributes to support the definition of sensor requirements for future missions in an objective, data-driven way.

O5 - Remotely sensed avian diversity in the high Andes of Ecuador

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The increasing impact of land use and climate changes has lead worldwide to modifications in structure and composition of natural ecosystems. To improve communication in conservation planning, managers and policy makers need spatially-explicit projections of biodiversity measures at the landscape scale. While ground-based biodiversity measures are time-consuming and expensive, remote

sensing data has been successfully used to predict animal and plant diversity across larger scales. In a system-based approach, predictions should include indicator systems unveiling changes in structural and functional biodiversity and important ecosystem processes. We chose avian species richness as valuable indicator for biodiversity in general and on top of this included phylodiversity as a measure for functional processes. For this reason, we use field data on birds in the mountain rainforest of southern Ecuador to analyze whether their phylogenetic information can be reflected by remote sensing data. To do so, we will apply active and passive remotely sensed landscape and habitat data to predict bird species occurrence and avian phylodiversity. Our findings will thus provide deeper insights on the potential to use remote sensing as surrogate for phylodiversity and functional processes.

O6 - Relating plant functional diversity to imaging spectroscopy in a heterogeneous grassland landscape

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Functional diversity is an increasingly used concept in the analysis of biodiversity patterns and their links with various ecosystem properties as well as their responses to environmental drivers. Functional diversity is commonly derived from standardized field sampling or ground surveys which are time consuming and costly and therefore not optimal for repeated study patterns and changes in diversity and ecosystem functioning on large spatial scales. Spectral observations from satellites or airplanes are a powerful alternative for estimating environmental heterogeneity and hence species diversity since it can provide a synoptic view of an area with a high temporal resolution. Remote sensing-derived plant species diversity estimation and mapping techniques generally take advantage of the relationship between species richness and habitat diversity, wherein species richness is hypothesized to increase with spectral heterogeneity. Surprisingly, so far, very limited attempts have been made to link spectral variation to measures of functional diversity instead of species diversity. Therefore, in this study we assessed the relationship between several measures of spectral variability and species and functional diversity for a heterogeneous grassland landscape in Belgium. We evaluated the performance of 3 different approaches to quantify spectral heterogeneity by cross-linking to species counts and functional diversity measures within 100 m² vegetation plots. Spectral variability was determined based on airborne hyperspectral data captured by the APEX sensor, capable to

provide a continuous spectrum of hundreds of narrow spectral bands across the visible, near-infrared and short-wave infrared spectral domain. Hence, this study aims to contribute to the debate on how to scale up the biodiversity-functioning paradigm from field observations to the ecosystem level.

O7 - Identifying robust canopy optical traits for vegetation mapping

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Maps of functional and compositional vegetation patterns are required in ecology, ecosystem modeling, and nature conservation. A frequently applied approach to generate such maps relies on imaging spectroscopy. In this approach, relations between a vegetation sample and the corresponding canopy reflectance are quantified based on statistical models and subsequently applied onto the imagery. Although several successful examples of such empirical applications exist, fundamental questions regarding the causal relations between vegetation patterns and canopy reflectance are still open. In particular, the role of canopy optical traits remains poorly understood. Canopy optical traits determine the reflectance signal of vegetation and include the canopy biochemistry as well as morphological and structural properties. Their influence on the relationship can be assessed based on an interpretation of model features such as measures of variable importance or regression coefficients.

Different modeling techniques may result, however, in a different set of spectral regions that are considered important for the relationship. This dependency of the relationship on the chosen methodology affects the interpretation towards a causal relationship. The identification of spectral regions on which different modeling techniques agree may help to deal with this issue. In the present study, a multi-method ensemble approach consisting of three different model types is used to determine spectral regions and related optical traits that allow to model compositional patterns in different mire and grassland types (raised bogs, transition mires, poor fens, and *Molinia* meadows). The performance of the ensemble as well as the role of the identified canopy optical traits are discussed.

P1 - Tree species classification in a Central European floodplain forest: using AISA Dual hyperspectral data.

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Multiple stressors such as river regulation, lowering of the groundwater level and soil drainage have dried out Leipzig's floodplain forest and caused shifts in species

composition and a loss of biodiversity. Because of re-vitalization projects (restoring floodplain dynamics) and advancing fungal diseases (e.g. causing ash dieback) such changes will continue in the future.

The objective of this study is to provide a remote sensing based monitoring system to monitor future changes in tree species composition, functional diversity and ecosystem services. Here, we report on a pilot study, which aimed for classifying tree species within Leipzig's structural- and species rich floodplain forest using data from an airborne sensor of high spectral (400-2500 nm, 367 bands) and spatial (2 m) resolution (ASIA Dual) in a supervised Random Forest classification. In order to reduce the spectral variability and to exclude tree crown shadows from the image a spectral mixture analysis (SMA) was conducted and different normalization techniques were compared in a pixel- and an object based classification approach. The minimum number of bands leading to an optimal separation of the tree species was identified using an importance based backward selection. Preliminary results indicate an overall classification accuracy of around 56% for 18 species in the object-based approach. Highest class-specific producer accuracy was achieved for *Populus balsamifera* L. (96%) with corresponding user accuracy around 85%. Variable selection indicated that the visible (VIS), red edge and shortwave infrared (SWIR) spectral regions are particularly relevant for tree species discrimination. We concluded that the AISA Dual sensor data in combination with the Random Forest classification algorithm has substantial potential for an automated species discrimination method.

END OF SESSION 28

Session 29 - The Role of education in conservation biology

CHAIRS: INES BRUCHMANN, TORSTEN RICHTER

O1 - The 2-MEV model and beyond: Towards Quantifying Environmental Citizenship

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A questionnaire battery designed to measure the factors Utilization (U) and Preservation (P) in the field of adolescent environmental perception was repeatedly administered to secondary school student populations. Maximum likelihood factor analysis confirmed the both hypothesized orthogonal factors U and P. Both domains construct the 2 factor Model of Environmental Attitudes (2-MEV), following a convention established by Rokeach (1973) employing the term to indicating sets of consistent attitudes. After the first publications, the 2-MEV model of Bogner and Wiseman (2006) was repeatedly tested by independent groups confirming the two orthogonal, robust and independent factors of Preservation and Utilization.

Based on Kaiser & Fuhrer (2003), the knowledge model includes (a) knowledge about how the environmental system works and how natural processes operate; (b) knowledge about how to achieve resource conservation and environmental preservation; and (c) knowledge about how best to achieve resource conservation—that is, knowledge about various behaviours' effectiveness in terms of energy savings or reduced carbon dioxide emissions.

Based on a sample of about 1,900 students, we calibrated previously established instruments for ecological behaviour (GEB), environmental knowledge, and attitude toward nature with Rasch-type models. By using path modelling, our theoretically anticipated competence structure revealed a modest behaviour effect on the behaviour set; attitude toward nature turned out to be, as expected, the stronger determinant of behaviour. Overall, we propose a competence model that has the potential to guide us into more evidence-based ways of promoting the overall ecological engagement of individuals.

O2 - Cognitive learning in authentic environments in relation to green attitude preferences

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Authentic activities within school schedules are rare, and if they exist, they are likely to last one day or less. Participating pupils are often more motivated and the

acquired knowledge level is higher and lasts longer. In our study, 185 fifth to seventh grade pupils participated in an out-of-classroom lesson at a major water supply institution. After an introductory film about drinking water, authentic learning sites were, for instance, purification spots or supply resources, were visited. Pupils saw the micron filters, the disinfection system with its highly active oxygen, and the rapid sand filters, which are the three purification steps at the Lake Constance water supply. We monitored environmental attitudes (using the 2-MEV scale), newly acquired knowledge, and responses to semantic differential items. Pre-knowledge correlated significantly with short and longer-term knowledge, short-term knowledge correlated with long-term knowledge. The (exploitative) Utilization did not correlate with acquired knowledge, while Preservation correlated significantly with short-term knowledge. Participants with high scores on Preservation also scored high on short- and long-term knowledge. Semantic differential items such as 'easy to understand' and 'motivating' showed a positive correlation with knowledge. The relevance of these results for schools is discussed.

This study was supported by the Federal Ministry of Education and Research (BMBF): "RiSKWa – Verbundprojekt PRiMaT: Präventives Risikomanagement in der Trinkwasserversorgung" (#02WRS1279L).

O3 - The effectiveness of eco-schools. Impact on students' and teachers' ecological values and motivation

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The current study aims to quantify the effect of schools' participation in the eco-schools (www.eco-schools.org) program on student and teacher motivation towards the environment (MTES) and their ecological values (2-MEV). We relate differences in effectiveness to differences in policymaking, in didactical approaches and the presence and use of green elements at school. The study includes 2152 students and 1374 teachers from 56 primary (grade 6) and 45 upper secondary schools (grade 12).

The eco-schools project seems to be stimulating the controlled rather than the autonomous motivation of both students and teachers (both in primary and secondary education). Furthermore as school progress through the eco-schools project from logo1 to green flag schools, the ecological values of their students change. That change is, however, not as we would want it be. The observed effect of eco-schools on utilization values but not preservation values, is another indication the project might not be achieving its goals.

Schools in which an integrated and a less rules-centered didactical approach to environmentalism is applied have students with less externally regulated motivation. Also students in schools that have more green spaces and make

didactical use of those spaces perform better. Schools in which the leadership regarding environmental education is shared among teachers rather than held by a key person, and that have common goals and a supportive network of teachers have teachers with less externally regulated motivation. These results illustrate that not only the participation in projects such as eco-schools are important, but also that didactics and school policies can be crucial in generating those educational effects that literature suggests are appropriate.

This study was commissioned by the Flemish government, which has coordinated the eco-schools project for almost 15 years in Flanders. The results have resulted in recommendations for refinements and adaptations to the project. The presentation at GfOE will also pay attention to the implementation of these results into a new concept for eco-schools in Flanders: eco-schools 2.0.

O4 - Ecological Values across Years, Ages and Locations

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Education has long been recognized as an important component of efforts to address environmental problems, providing the foundations of environmental awareness and concern about human impacts (Bogner, 1998, 2004; Gigliotti, 1990). Many environmental education programs, however, focus primarily on environmental issues and problem-solving skills, failing to address the value and behavioral (action) components (Johnson & Manoli, 2011; Waliczek & Zajicek, 1997). Empirical studies provide clear evidence that addressing knowledge alone is not enough to lead to changes in behavior (Johnson & Manoli, 2008). Increasingly, educational programs are recognizing the importance of specifically addressing values in affecting behavioral change. For example, earth education programs are designed to include values and behavioral components, while still addressing ecological understandings (Wohlers & Johnson, 2003; Van Matre, 1991). In this study, the environmental values of over 10,000 children ages 9 to 14 who participated in earth education programs over a 10 year period were examined. Analyses included examination of trends in the initial (pre-program) value scores over the 10 year period and comparisons of values at different ages. In addition, values scores of children participating in the same programs and three very different locations (with very different demographics) were examined. Results reveal few changes in initial values over the 10 years but significant differences when looking at the ages of participants and across locations.

P1 - What's life? - learn by research

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First-year students of biology contribute a broad range of motivations and interests which were normally not attend within the regular Curricula. With „What's Life?“ we pursue the goal to conserve or enhance these motivations via learn by research as learning strategy. Key features for the students are the temporal flexibility, the lack of mark pressure and the insight in the actual research work of the faculty. „What's Life?“ is a modularized package of courses to enable students to create an own scientific project, just after they start with their study course in Biology. The students get key-qualifications in scientific work, project planning, scientific writing and presentation techniques. Thus, the young students could be very fast integrated in actual running research within their faculty. Within a research group they finalize the development of their student project, conduct it and present it afterwards in front of their fellow students and as inspiration for the next generation of researching students. This active and creative learn strategy enhance and preserve the own interests and motivations of the students and leads them to understand the necessity of several items of the course programm. Our first experiences and evaluations by prae and post surveys confirmed our goal to create motivated self thinking students highly interested on research. If this could be reflected in an enhanced quality of their Bachelor thesis, have to show the upcoming thesis of the first students going through this program. First external reactions to this program were very positive. „What's Life?“ became the Faculty award of the Stifterverband für die Deutsche Wissenschaft 2013.

END OF SESSION 29

Session 30 - IPBES goals and procedures

CHAIRS: ALETTA BONN, STEFAN HOTES

O1 - IPBES Intergovernmental Platform on Biodiversity and Ecosystem Services

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The *intergovernmental science-policy platform on biodiversity and ecosystem services* (IPBES) will respond to requests for scientifically proven information on biodiversity and ecosystem services coming from Governments, Multilateral Environmental Agreements and other stakeholders.

The IPBES provides a unique opportunity for:

- a) Identifying credible scientific information needed by policymakers;
- b) Performing assessments of knowledge on biodiversity and ecosystem services;
- c) Supporting policy formulation and implementation by identifying policy-relevant tools and methodologies;
- d) Prioritizing key capacity-building requirements needed to strengthen the implementation of its activities.

To ensure its effectiveness, the IPBES will collaborate with existing initiatives, and provide unbiased scientific information that has been collected, validated and synthesized through transparent, independent and peer-reviewed processes.

The Federal Ministry of Education and Research (BMBF), and the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) have established the German IPBES Coordination Office to e.g. identify national experts and capacities that can support the IPBES activities, and to assist experts in getting involved in the IPBES.

This presentation will outline the IPBES process, discuss the role of existing initiatives, and describe how experts can get involved.

O2 - Challenges and Opportunities in the Establishment and Management of Regional and National Clearing-House Mechanisms (CHMs) in the ASEAN Region

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As signatories to the CBD, the 10 ASEAN Member States (AMS) of Southeast Asia (SEA) have signified their commitment to manage, conserve, protect, and sustainably use the diverse biological resources within their national jurisdictions, and thus, that of the ASEAN Region. Through this commitment to the CBD, the AMS

are encouraged to demonstrate and report on their progress towards reducing biodiversity loss through a national clearing-house mechanism (CHM). The CHM would ideally contain organized information on species and protected areas to facilitate tracking and monitoring conservation and protection efforts.

The ASEAN Centre for Biodiversity (ACB) was established in 2005 and overseen by a Governing Board, to facilitate and coordinate technical and scientific cooperation in SEA. Part of this mandate is providing technical support to AMS in meeting their obligations to CBD including national CHM establishment. The establishment and management of national CHMs were challenged with needs for funding, data translations, technical expertise, dedicated staff and data in interoperable formats, among others. These issues hindered ACB's efforts to deliver on a current regional picture of the status and trends of the Region's biodiversity, and related conservation and protection efforts.

To address these limitations, ACB facilitated access to funds, technical support, training, and encoding tools for appropriately recording species and protected areas – related data (that conforms to globally accepted formats to facilitate data integration and analysis). To date, eight out of the ten AMS have national CHMs, of which, five are fully operational. At the regional level, the ASEAN CHM (www.chm.aseanbiodiversity.org) was established and currently maintained to serve as “one-stop-shop” for biodiversity information in SEA. It is supported by partnerships with global scientific organizations (e.g., GBIF, SEAOBIS, APBON, UNEP-WCMC, Birdlife, etc.).

As AMS gain expertise in managing their national CHMs, more interoperable species and protected areas are generated to support science-based decision and policy making both at the national and regional levels. This puts the ASEAN region in a better position to contribute to scientific and policy initiatives at the global level.

O3 - Macroecology meets IPBES: Opportunities and challenges at the science-policy interface

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Biodiversity loss has been identified as one of the most urgent problems our planet and humanity is facing. With the formation of the Intergovernmental Platform for Biodiversity & Ecosystem Services (IPBES), the United Nations have acknowledged this challenge at an institutional level. The exchange of knowledge and wisdom between science and policy is crucial for the success of IPBES, in order to halt the global loss of biodiversity.

With its strengths in global biodiversity modelling and scenario development, the discipline of macroecology has the potential to become an important contributor to

the IPBES process. Here, we will highlight the potential contributions of macroecology to IPBES and present the outcomes of the recent workshop "Macroecology meets IPBES" which was held as a satellite workshop during this year's annual meeting of the Macroecology Specialist Group of the GfÖ and which was supported by NeFo (Network-Forum for Biodiversity Research Germany). In this workshop, the question of how ecological science can contribute to the process of developing IPBES as a successful science-policy platform was discussed. Our presentation will focus on the topic of biodiversity data as well as opportunities and challenges in novel initiatives that aim to model biodiversity and ecosystem services.

O4 - IPBES - first experiences in the context of the pollination

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Through the role as CLA (Coordinating Lead Author) of the drivers chapter in the pollination assessment, first insights into and experiences within the IPBES-process could be gained. These will be presented on the background of and in comparison with the CLA work on "Terrestrial and Inland Water Systems" within WGII (Working Group II) of the 5th Assessment Report (AR5) of the IPCC (Settele et al., 2014), which - like the entire report of Working Group II - was just recently finished.

Settele J, Scholes R, Betts R, Bunn S, Leadley P, Nepstad D, Overpeck JT, Taboada MA (2014). Terrestrial and Inland Water Systems. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field CB, Barros VR, Dokken DJ, Mach KJ, Mastrandrea MD, Bilir TE, Chatterjee M, Ebi KL, Estrada YO, Genova RC, Girma B, Kissel ES, Levy AN, MacCracken S, Mastrandrea PR, White LL (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA

O5 - Active and efficient participation - how does this principle play out during the initial phase of IPBES?

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According to its agreed operating principles, the *Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services*, IPBES, is committed to an interdisciplinary and multidisciplinary approach and to an interactive collaboration with existing initiatives. It recognizes that it may only comply with its mission of providing credible and independent information if it engages efficiently with various knowledge holders.

In this talk, we scrutinize how the engagement with knowledge holders has actually played out during the initial phase of IPBES. In particular, we look at the different options for engagement that the IPBES process has offered so far (such as the first round of calls for nominations of experts) to analyse the effectiveness and inclusiveness of its outreach and engagement efforts with regard to the knowledge holder community. The lists of experts engaged in ongoing IPBES activities serve as one source of information. They are analysed with regard to the representation of different stakeholder groups, knowledge systems, scientific disciplines, countries, regions or gender. In addition, we compare the nomination procedures that have been implemented in Germany and other IPBES member states to identify elements that may encourage or discourage the active and efficient participation of different stakeholder groups. We also intend to include first results from a survey among knowledge holders in our analysis. Furthermore, we draw on our observations of the development of the IPBES Stakeholder Engagement Strategy and the respective negotiations during the first two IPBES plenary meetings in 2013 to identify possibilities or obstacles for the participation of different stakeholder groups.

We use our results to reflect whether IPBES has met its own standards during its initial phase of operation and to frame recommendations on where and how it should strive to achieve more inclusiveness.

O6 - Scenarios for IPBES - what can ecology contribute to our thinking about the future?

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Following the model of the climate change community and the Millennium Ecosystem Assessment (MA), the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) will use scenarios of future developments in its assessments. As a first step, Deliverable 3(c) 'Policy support tools and methodologies for scenario analysis and modelling of biodiversity and ecosystem services based on a fast track assessment and a guide' is scheduled to be finished by August 2015. The outcome of this fast-track assessment is expected to play an important role in the compilation of the regional assessments and the global assessment that are planned within the first work programme of IPBES until 2018. The purpose of scenarios in assessments is to provide a consistent framework for thinking about possible pathways that socio-ecological systems may take, based on assumptions about cause-effect chains in such systems. Previous scenario development exercises have shown that the most important effect of creating scenarios is the communication process it initiates, and that the actual veracity of the scenarios is secondary. Nevertheless, the ultimate scientific goal in creating and analyzing scenarios using a variety of models is to reach a better understanding of system dynamics, and this should lead to improved predictive capabilities that can support informed and transparent decision-making. Because of IPBES' scale-crossing approach there are particular challenges involved in the extensive consultation of stakeholder groups it will require. Furthermore, the relative scarcity of general, quantifiable relationships in ecology, dynamic feedbacks between and among ecological and socioeconomic variables are currently difficult to integrate in scenarios and scenario-based modelling. This paper reviews relevant scenario exercises and the ecological information that has been used in generating projections of future trends, and it discusses options for improving the contribution of ecology to scenarios for IPBES, drawing in particular on examples from soil ecology.

O7 - IPBES-CH: a national platform for IPBES in Switzerland

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The Swiss Biodiversity Forum, in collaboration with the Federal Office for the Environment, FOEN, is organising an interface and platform for exchange between IPBES (Intergovernmental Science-Policy Platform for Biodiversity and Ecosystem Services) and the Swiss policy and science communities on biodiversity. The aim is to mobilise experts on biodiversity, and key organisations and stakeholders in Switzerland for the IPBES process and deliverables of its programme of work 2014-18, and to inform the biodiversity community in Switzerland on IPBES outcomes and conclusions. A kickoff meeting of IPBES-CH in 2012 showed that Switzerland is

well placed to take an important role in IPBES, with a high density of organisations and experts organised in various national and international networks.

The Swiss IPBES platform organises national and pan-European IPBES workshops, provides information on IPBES and its possibilities for participation via the platform's webpage (<http://www.biodiversity.ch/e/ipbes/>). Beyond, the Swiss Biodiversity Forum supports the Federal Office for the Environment, FOEN in IPBES in nominating experts and identifying scientific topics relevant for IPBES, providing expertise for the Swiss delegation in IPBES plenaries and input on IPBES documents. In collaboration with other European platforms, the Swiss IPBES platform is organising the next IPBES Pan-European stakeholder meeting (PESC-2) on 22 & 23 September 2014 in Basel, to ensure a broad engagement of scientific experts, local knowledge holders, policy makers and NGOs of the Pan-European region for the forthcoming IPBES regional Pan-European assessment.

END OF SESSION 30

Session 31 - Human impacts on floodplain ecosystems in central Europe

CHAIRS: LARS GERMERSHAUSEN

P1 - Black Poplar Population Persistence - Black poplar (*Populus nigra*) metapopulation persistence in a simulated floodplain

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Floodplain forest areas have been drastically reduced due to stream regulation and anthropogenic changes. This poses a serious threat to floodplain species such as black poplar (*Populus nigra* L.). As a pioneer species, the black poplar tree has special demands for successful rejuvenation because of its low competitiveness compared to other species. Due to lack of natural rejuvenation, the existing black poplar populations in Germany have a relatively high mean population age. Another threat to native black poplar persistence is introgression with poplar hybrids, which are used for short rotation coppice. Black poplar is therefore counted as vulnerable species on the Red List of Germany. Management approaches to enhance black poplar metapopulation persistence include protected areas, plantings of black poplar cuttings in existing populations and establishment of new populations to maintain metapopulation dynamics between local populations. However, it often remains unclear how effective these management actions are in terms of protecting black poplar and enhancing the metapopulation viability. Individual-based modelling provides a relatively fast, scientifically recognized and low-cost alternative to long-term efficiency assessments in the field. Based upon existing knowledge, I have developed an individual-based simulation model to study the ecological and economic effectiveness of different management scenarios of black poplar populations. Additionally, I want to identify processes that are particularly sensitive with respect to metapopulation viability. The results can help to improve existing protection plans and optimize the localization of interventions. The model will also advance ecological knowledge about black poplar and diecious species in general.

P2 - An urban floodplain forest in Leipzig: assessment of tree fine root biomass

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This study is attached to the “Lebendige Luppe”-project in Leipzig (Universität Leipzig, UfZ). One of the overall goals of the project is the assessment of floodplain forests functions and biodiversity against the background of future sustainable management and maintaining ecosystem services. The presented research focusses on the belowground part: the fine roots as an important part of the overall biomass

and carbon stock of the forest. It takes place at the Leipzig 'Luppe-Aue'. In total, a subset of nine plots were selected from the projects plots along a hydrological gradient differing in groundwater level (GWL), including wet ($GWL \leq 1m$), medium ($GWL 1-2m$), and dry ($GWL \geq 2m$) areas.

30 sampling points in each plot were randomly selected; soil samples were taken in 0-10cm and 10-30cm soil depth with a soil corer. Samples were washed out on a sieve and root segments $>10mm$ were picked out. Different tree species were distinguished based on identification keys modified for local species. The sorted roots were dried to determine fine root bio- and necromass. For a subsample of every tree species the root surface area was measured using the scanning software WinRhizo to calculate RAI (root-area-index).

Total fine root biomass decreased strongly with soil depth at all plots. Significant lower values of root biomass were found at the wet sites compared to dry and medium sites which showed no significant difference. Compared to the wet site a higher below-ground diversity of tree species was determined at dry and medium sites. Roots of 13 tree or shrub species were found in the soil samples, differing widely in their percentage of total biomass and between the sites. Only at wet sites samples without any roots at all were collected while at dry sites a maximum of 6 species concurrent were found. On the other hand RAI showed no significant differences between the plot categories.

END OF SESSION 31

Session 32 - Free Session

P1 - Physical soil properties influence large scale forest condition

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Level II is the intensive forest monitoring network established under the umbrella of the UNECE in the 1980s. Regular surveys on permanent plots collect comprehensive data sets on the state of European forest trees, soils, and ground vegetation.

Here available water capacity (AWC) and tree rank within each plot were taken as predictors following the hypotheses that 1) soil is a predisposing factor for tree condition and 2) differences caused by stand structure and social class influence defoliation estimates.

AWC is a significant explanatory variable for defoliation of the main European tree species. Variations between species are likely due to individual species breadth of adaptation to varying substrates. Results highlight the importance of substrate for large-scale tree condition estimates and confirm that soil is a predisposing factor for defoliation. One possible explanation is that trees tend to adapt to lower AWC by reducing the amount of foliage produced while increasing water use efficiency.

P2 - Direct and indirect effects of climate change on decomposition activity of macroarthropods

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In view of the expected climatic changes for Central Europe, including a higher frequency of hot and dry summer periods, Mediterranean drought-resistant oak species are being evaluated as future forest trees into dry forests sites in Germany. Since the planting of foreign tree species results in a change of leaf litter composition and hence in altered nutrient resources for litter decomposing soil arthropods, it might affect primary decomposition processes that play a major role in nutrient cycle. Changing abiotic climatic conditions like an increase of temperature and reduced soil humidity could furthermore directly influence the decomposition ability of saprophagous macroarthropods. Therefore, laboratory feeding experiments with native diplopods and isopods were performed to assess the acceptance of introduced leaf litter in comparison to native leaf litter. In subsequent experiments the influence of temperature and soil moisture on the

decomposition activity of a native and Mediterranean arthropod species was tested and consumption of native leaf litter (*Quercus robur*) and introduced leaf litter (*Quercus frainetto*) under these conditions was compared for each diplopod and isopod species. Decomposition of native leaf litter (*Fagus sylvatica*, *Quercus robur*) and Mediterranean leaf litter species (*Quercus frainetto*, *Quercus pubescens*) in the field was studied in litter-bag experiments. The results of the feeding experiments reveal that leaf litter of Mediterranean tree species is readily accepted and in some cases even preferred by native litter decomposers. These findings are strengthened by the results of the litter bag study where litter of introduced tree species was decomposed at faster rates than that of native trees. Feeding activity increases with increasing temperature. Again, even at higher temperatures all arthropod species consumed the foreign leaf litter at about the same rate as native leaf litter. The results of the study implicate that the introduction of Mediterranean oak species does not negatively affect the decomposition function of native diplopods even under different climatic conditions.

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