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1.1. Arctic and Alpine Biodiversity and Ecology

Markus Fischer, Jürg Stöcklin, Christian Rixen

Oral presentations

Upward shift of alpine plants increases floristic similarity of mountain summits

Gerald Jurasinski
Author information missing

Plant species might shift there ranges as a response to ongoing climate warming. Mountain Summits provide an ideal natural observatory for range shifts on a relatively small scale. However, baseline data reaching back in history are rather scarce. Where they are available, upward shifts of species ranges are already observable.

Based on a data set from a previous study of Summits in the Bernina region of the Swiss Alps that in part dates back to 1907 (relevés were obtained by Rübel) we expanded the analysis from a pure species richness approach to beta-diversity and spatial heterogeneity. We hypothesized that the upward shift of species, induced by climate change, leads to homogenization of Alpine summit vegetation.

We compared the species composition on mountain summits at three steps in time (1907, 1980, 2003) using a two-component heterogeneity concept including the mean and the variance of Sørensen similarities calculated between the summits. Non-metric multidimensional scaling has been applied to explore the developments of single summits in detail.

Both heterogeneity components (mean dissimilarity and variance) have been found to decrease over time, indicating a trend towards more homogeneous vegetation among Alpine summits. However, the development on single summits is not strictly unidirectional. We show that the upward shift of plant species leads to homogenization of alpine summit regions. Thus, increasing alpha-diversity is accompanied by decreasing beta-diversity. Beta-diversity demands higher recognition by scientists as well as nature conservationists as it detects changes which cannot be described using species richness or other coefficients of alpha-diversity alone.

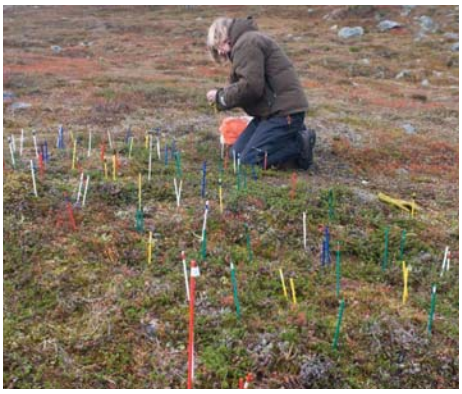
Barriers for colonization and range expansion of subarctic plants in a future climate

Ann Milbau (1,2), Bente Graae (2)& Ivan Nijs (1)
(1) University of Antwerp, Universiteitsplein 1, 2610 Wilrijk, Belgium
(2) Climate Impacts Research Centre, Umeå University, 98107 Abisko, Sweden

In the autumn of 2007, we set up a large seed-sowing experiment along an altitudinal gradient (resembling a temperature gradient; maximum temperature difference +/- 3°C) near the subarctic research station of Abisko, Northern Sweden (68°21'N, 18°49'E). At each of 5 different altitudes (between 500 and 900 m a.s.l), seeds of 24 different species, belonging to different growth forms and varying in their current distributions, were sown in 4 different vegetation types (20 combinations of altitude × vegetation type; 3 replicates each; 60 plots in total). The selected vegetation types (Salix shrubs, herbs, rich heath and poor heath) corresponded with a snow depth gradient. To compare germination and seedling establishment between disturbed and intact vegetation, we created in each plot 3 disturbance treatments (no disturbance, gaps of 3 cm diameter and gaps of 6 cm diameter) for each of the 24 species. To avoid misidentification of the seedlings, all species (each time 30 seeds) were sown in individual gaps (or intact vegetation).

In this study we focus both on the influence of the colonizing species (growth form, functional type, seed mass, …) and the colonized (or invaded) plant communities. Apart from the effects of altitude, vegetation type and disturbance, we measure a wide range of biotic (biomass, % cover, species composition, species richness, functional richness, thickness of the humus layer, …) and abiotic (temperature, nutrient availability, light penetration, soil moisture, length of growing season, …) factors and determine how they affect plant colonization. We also establish how these different biotic and abiotic factors change with altitude, vegetation type, and disturbance regime.

In addition to the outdoor experiment, we are running a germination experiment in incubators with seeds from the same 24 species. In this experiment, we test the effects of cold stratification temperatures (comparing a thick insulating snow layer with a thin snow layer) and of warm incubation temperatures (resembling the highest and the lowest plots of our gradient) on germination. Also germination in 'ideal' temperatures is measured, to determine the quality of the collected seeds. We will present the first-year results of both experiments (the colonization experiment and the incubator experiment) at the conference.



Sensitivity of arctic-alpine/boreal plant species to climate warming during different stages of early seedling establishment

Anna Shevtsova (1), Bente Graae (2), Till Jochum (3), Ann Milbau (1,2) & Ivan Nijs (1)
(1) Research Group Plant and Vegetation Ecology, Department of Biology, University of Antwerp, Campus Drie Eiken, Universiteitsplein 1, B-2610 Wilrijk, Belgium
(2) Climate Impacts Research Centre, Umeå University, Department of Ecology and Environmental Sciences, 98107 Abisko, Sweden
(3) Department of Plant Ecology, Botanical Institute, University of Tübingen, D-72076 Tübingen, Germany

Climate warming is predicted to occur earlier, to be of a greater magnitude, and to have more pronounced effects on high-latitude ecosystems compared to other terrestrial ecosystems. Such warming is expected to shift bioclimatic zones and thereby to force plant species to shift their range distribution. The rate and success of plant species migration and the persistence of resident plant populations will depend inter alia on the establishment abilities of individual species and their sensitivity to the direct and indirect components of climate warming. However, still little is known about the potential effects of warming on life history stages such as seed germination and seedling establishment, despite these stages are considered as a bottleneck in population dynamics. In the present study, we aimed at providing experimental evidence on how establishment potential of plant species in sub-arctic tundra may change under conditions of climate warming. Specifically, the goal was to test the sensitivity of different stages of early seedling establishment of a range of arctic-alpine and boreal plant species and plant functional types to the direct effects of growing season warming.

We performed a semi-natural seed sowing experiment in Northern Sweden (Abisko), in which seeds of 15 species were sown in containers placed under the field conditions in sub-arctic tundra heath and were treated by eight combination of heating periods (factorial combinations of three periods of summer warming) and 2 levels of water addition (ambient and +30% increase in summer precipitation). Heating treatments mimicking +2.5°C elevation of air temperature above ambient were achieved by using Free Air Temperature Increase systems (FATI) [1].Combined analysis of study species demonstrated that early and late growing season warming negatively affected seed germination, while heating during any of the three heating periods caused decreased seedling establishment. Addition of water generally could not counterbalance negative effects of heating. This implies that anticipated increase in summer temperatures may present a significant constraint on seed germination and seedling survival in tundra, at least on open, disturbed sites, which is a common seed regeneration niche in this ecosystem. The studied species, however, demonstrated variation in responses to the treatments; e.g., Pinus sylvestris was strongly negatively affected by heating and the strength of response linearly depended on the duration of heating, Vaccinium vitis-idaea was positively affected by water addition only, while Deschampsia flexuosa was unaffected by any of the treatments. Species-specific responses to summer warming are discussed against functional types and differences in a present range distribution of the species.

[1] Nijs, I., Kockelbergh, F., Heuer, M. et al. 2000. Climate-warming simulation in tundra: enhanced precision and repeatability with an improved infrared-heating device. Arctic, Antarctic, and Alpine Res. 32: 346-350.

The sensitivity of the small scale vascular plant species distribution in snowbeds to climate change

Christian Schöb (1), Peter M. Kammer (2), Philippe Choler (3) and Heinz Veit (1)*
(1) University of Bern, Institute of Geography, Hallerstrasse 12, 3012 Bern, Switzerland
(2) University of Teacher Education, Biology Department, Gertrud-Wokerstr. 5, 3012 Bern, Switzerland
(3) University J. Fourier Grenoble / Laboratoire d'Ecologie Alpine, 38041 Grenoble, France
**Corresponding author: christian.schoeb@phbern.ch*

Alpine snowbeds are characterised by a long lasting snow cover and low soil temperature during the growing season. Both of these climatic factors limiting plant life in snowbeds are sensitive to climate change. Thus, environmental conditions in snowbeds will alter to a considerable extent. To predict changes in species composition in snowbeds caused by climate change, we determined climate envelopes of all vascular plant species by analysing the small scale species distribution along the snowmelt and soil temperature gradients within alpine snowbeds in the Swiss Alps. We found that snowmelt date and soil temperature were relevant abiotic factors for the small scale species distribution within alpine snowbed communities. Species richness was reduced to about 50% along both of the environmental gradients towards later snowmelt date (Fig. 1) and lower daily maximum temperature. We established a categorisation of species based on the occurrence pattern of the species along the snowmelt gradient. This categorisation allowed different predictions of the future distribution of vascular plants growing in snowbeds. The typical snowbed species increased in frequency and relative cover with later snowmelt date. They will be the most suffering species due to the loss of their habitats as a consequence of earlier snowmelt dates in the future. The dominant species increased their relative cover with later snowmelt date and will, therefore, also lose abundance due to climate change, but resist complete disappearance from the snowbeds. Both, the categories of indifferent species to snowmelt date and the transient species, increased in species richness and relative cover with higher temperature and will profit from climate warming. The grassland species growing in snowbeds so far will be the main profiteers in the future. They will take advantage from an increasing number of suitable habitats due to an earlier start of the growing season and increased temperature. As a result, they will carry on invading snowbeds and probably replace the snowbed species, even in the late melting sites. Therefore, the characteristic snowbed vegetation will change to a vegetation unit dominated by alpine grassland species. This study highlights the vulnerability of the established snowbed vegetation to climate change and requires further studies particularly about the role of plant-plant interactions in the predicted invasion and replacement process.

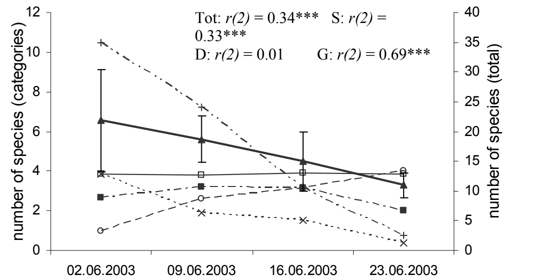


Figure 1. Number of species along the snowmelt gradient. All species Tot (—▲—); the five categories: dominant species D (—□—), indifferent species to snowmelt dates I (– · –■– · –), snowbed species S (– –○– –), grassland species G (– · · –+– · · –), and transient species T (- -x- -). Error bars indicate ± 1 SD for each snowmelt date.

Climate effects on Atlantic salmon in the White and Barents Seas during the 17-20th centuries

Dmitry Lajus
St. Petersburg State University, Department of Ichthyology and Hydrobiology,, 16 linia V.O. 29, 199178 St. Petersburg, Russia

Barents and White seas area is a northeastern boundary of distribution range for many boreal Atlantic species. Thus response of species on climate changes there should be very pronounced and this region represents a convenient model for studying climate effects on ecosystems. It is of especial interest historical data because they allow us to get long-term series and to study populations and ecosystems in periods when human pressure was very low. Atlantic salmon is a good object for historical studies as it was a very important commercial fish in the Russian European North. In the region where agriculture is possible only in a very limited extent, salmon was exported outside the region and was one of the main resources of its colonization. Due to this salmon fisheries kept accurate records and left abundant historical information allowing reconstruction of past population dynamics. Moreover, salmon for centuries were caught in the same places and by the same fishing gear during their spawning migrations that makes data obtained in different periods easily comparable. Salmon spend from one to five years in rivers and up to three-four years in the ocean where they intensively feed and quickly grow. Feeding area of Atlantic salmon is located around Faroe Islands and Western Greenland. According to recent data mortality of salmon in the ocean is more variable than in rivers, and thus fluctuation of salmon populations in a greater extent depends on conditions in the oceans. Therefore abundance of salmon in Russian rivers reflects state of ecosystem of open Atlantic Ocean. In this study we discuss data on dynamics of population abundance of Atlantic salmon for period from the 17 to 20th century and correlate them with temperature series for Northern hemisphere. Our analyses based on numerous historical documents referring different populations of Atlantic salmon within the region showed that abundance of populations was lower in colder periods in comparison with warmer period during 17-20th centuries. In addition to changes in population abundance, we found considerable fluctuating of weight of fish, in particularly, in 1763 (cold period) average weight of fish more than twice exceeded that in other periods. It is noticeable that overall abundance of salmon in the 17-18th did not differ from abundance in the end of the 19th century, when official fisheries statistics became available. Thus during this period changes in populations were mostly caused by climate changes. Effect of human pressure, in particularly, fisheries and forestry became evident since end of the 19th – beginning of the 20th centuries when anthropogenic factors became dominant in determining fluctuation of salmon populations confounding climate effects. Analysis of long-term historical series demonstrated that effect of temperature change on abundance and weight of boreal species such as Atlantic salmon is clearly manifested. Fluctuations in salmon populations probably reflects changes in the entire ecosystem of North Atlantic and thus should be taken into account while modeling response of ecosystem to global changes.

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Spatial genetic structure of *Campanula thyrsoides* mirrors postglacial recolonization and reveals four evolutionary units

J.F. Scheepens (1), G.F.J. Armbruster (1), H.H. Ægisdóttir (1), P. Kuss (2) & J. Stöcklin (1)*
(1) Institute of Botany, University of Basel, Schönbeinstrasse 6, 4056 Basel, Switzerland
(2) Institute of Plant Sciences, University of Bern, Altenbergrain 21, CH-3013 Bern, Switzerland
** Corresponding author; email: jf.scheepens@unibas.ch*

Campanula thyrsoides is a self-incompatible, yellow-coloured bell flower living as a pioneer in semi-open calcareous habitats. It is one of the few monocarpic perennials occurring from east to west in the entire alpine belt. As several other species, this taxon probably survived the last ice age(s) in glacial refugia in the forelands east, south, west and probably also north of the Alps [1,2]. We studied microsatellite profiles in populations covering the entire distribution area, aiming to reveal large-scaled evolutionary units related to refugial origin. We tested five highly polymorphic and unlinked microsatellite loci in genomic DNA of 1196 individuals from 52 alpine populations. With individual-based cluster modeling (using STRUCTURE) we found clear support for four spatial groups with little overlap: i) most-western Switzerland together with adjacent Savoie (France), ii) from western Switzerland to eastern Switzerland, iii) most-eastern Switzerland to central Austria, and iv) the south-east of Austria together with populations from Slovenia and Italy. The four groups can be interpreted as evolutionary units resulting from recolonization from different adjacent glacial refugia, with currently low gene flow among them. Our results indicate that gene flow during the last millennia was not able to eliminate the genetic imprint of postglacial recolonization history. STRUCTURE indicates a division into four spatial evolutionary units. An AMOVA on 859 individuals from the 52 populations supports a west-east differentiation. An among-group variance of 7% was detected in the entire data set. Remarkably, the most eastern evolutionary unit from Austria, Slovenia and Italy showed higher differentiation from the remaining populations (7.8%) compared to other evolutionary units (2-3%). This finding may be linked with the description of a subspecies *C. t. carniolica* reported to occur in the eastern Alps [2]. So far, a convincing biological, biogeographical and/or taxonomic delimitation of *C. t. carniolica* from its nominate species *C. t. thyrsoides* is still missing. It is noteworthy that neighbour joining clustering with PHYLIP, typically used in resolving phylogenetic relationships among species, does not support the split in four evolutionary units. Bootstrap values of the neighbour joining furcations were generally low (i.e. < 50%). We therefore recommend STRUCTURE to find potential spatial differentiation, particularly if among-group molecular variance is low.

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[2] Kuss, P., Ægisdóttir, H.H., Stöcklin, J. (2007) The biological flora of Central Europe: Campanula thyrsoides L. Perspectives in Plant Ecology, Evolution and Systematics 9: 37-51.

Biodiversity losses in Scottish Alpine vegetation: what are the key drivers?

Alison Hester, Andrea Britton, Colin Beale, Willie Towers & Richard Hewison
Macaulay Institute, Craigiebuckler, Aberdeen AB15 8QH, UK

Biodiversity change in alpine areas is of global concern; high levels of endemism, glacial refugia and geographical isolation combine to produce unique reservoirs of biodiversity which are vulnerable to changes in climate, atmospheric pollution and land use[1,2,3]. In Europe, alpine areas cover only 3% of the land area but contain about 20% of the vascular plant flora[3]. Good, long-term records of vegetation change in mountain areas can give important insights into the drivers of biodiversity changes which have already occurred, and thus increase our ability to predict and manage for the future.

Scottish alpine vegetation, with its unique combinations of arctic, alpine and temperate flora and strong oceanic influence[4] is considered highly vulnerable to predicted global changes. Between 1963 and 1987, detailed vegetation and soil records were collected from 677 alpine sites across Scotland[5,6]; a subset of 205 sites were resurveyed between 2004 and 2006, giving a wide geographical distribution and range of habitat types (Fig. 1). This paper reports some results of our analyses of biodiversity changes over this 30-40 year period and explores the likely main drivers of the changes recorded.

Figure 1: Distribution of old and new (closed

Significant changes were found in species richness, plot scale diversity and β-diversity, with regional differences both across and within habitats and species groups. Although species richness showed an overall increase, a significant overall decline in β-diversity was detected, indicating that all vegetation communities were becoming more similar in their species composition. Previous research has suggested that 'closed' communities (such as many of those found on Scottish mountains), which comprise slow growing species and have few gaps for new colonisation, should be relatively resistant to change in comparison to the more 'open' alpine-nival transition zone communities which have been more widely studied. However, our results support more recent findings from the Alps[7] suggesting that alpine vegetation change may acually be less predictable and more rapid than previously assumed.

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[2] Körner C. 1995 in: Arctic and Alpine Biodiversity: patterns, causes and ecosystem consequences (eds F.S. Chapin III, C. Körner), pp. 45-62, Springer, Berlin.
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[5] Birse, E.L. (1984) The phytocoenonia of Scotland: additions and revision. MISR, Aberdeen.
[6] Birse, E.L. (1980) Plant communities of Scotland: a preliminary phytocoenonia. MISR, Aberdeen.
[7] Cannone, N., Sgorbati, S. & Guglielmin, M. (2007) Frontiers in Ecology and the Environment 5, 360-364.

Impact of farm size and topography on Alpine grassland biodiversity

Lorenzo Marini (1,2), Paolo Fontana (1), Sebastian Klimek (3), Andrea Battisti (1), Kevin J. Gaston (2)*
(1) University of Padova, Department of Environmental Agronomy and Crop Production, Viale dell'Università 16, 35020 Legnaro, Padova, Italy
(2) University of Sheffield, Department of Animal and Plant Sciences, Biodiversity and Macroecology Group, Sheffield S10 2TN, UK
(3) University of Göttingen, Research Centre for Agriculture and the Environment, Am Vogelsang 6, 37075 Göttingen, Germany

Since the second half of the 20th century, European mountain areas have experienced a structural transformation of farms from small, traditional to large and specialized farms. However, detailed studies on the impact on biodiversity of factors related to farm structure such as size or specialization are still lacking. In this study, we unravelled the influence of farm size and slope on grassland biodiversity in a region of the Alps. We defined three farm size classes representing different farm structures from small traditional to large and specialized, and tested the influence of farm size along with slope on the diversity of plants, orthopterans and butterflies in hay meadows using linear mixed models. Our results showed a strong positive effect of slope and a negative influence of farm size on species richness of the three taxonomic groups (Figure 1). The high positive influence of slope on species richness was an indirect effect related to the farmers' behaviour, who managed steep meadows less intensively than flat ones. Large, specialized farms were strongly associated with higher stocking rates and higher soil fertility than small traditional farms, irrespective of meadow slope. The negative impact of large farm management on biodiversity should mainly be related to the higher degree of intensification at the whole-farm level.

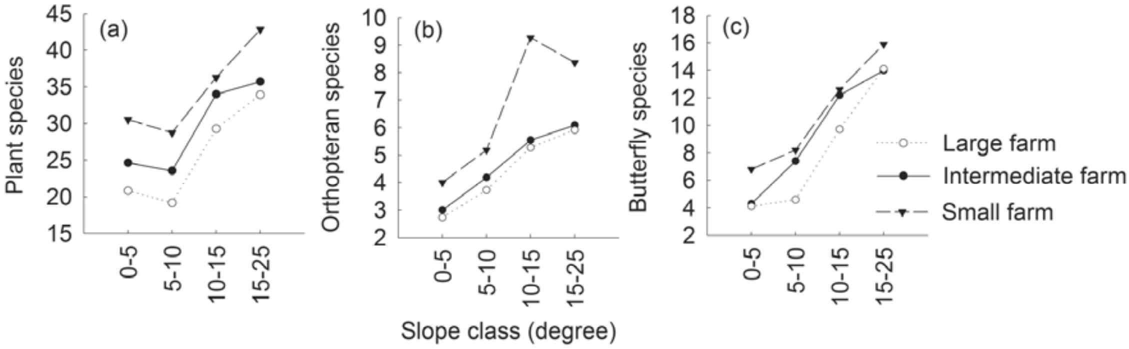

Figure 1: Species richness of vascular plants, orthopterans and butterflies in function of slope and farm size in Alpine hay meadows.

Local stakeholders should consider targeted agri-environment schemes (AES) to reduce the ongoing substitution of small farms with large intensive farms, although multi-disciplinary research studies are necessary to evaluate the socio-economic sustainability of these schemes. A complementary solution could be to target future AES to support farms with low stocking rates and to reward the maintenance of the current management of steep meadows. In our Alpine region, both reduced stocking rates and maintenance of low-intensity management of steep areas, could be achieved even by large farms, therewith reducing the negative impact of the current transformation of agricultural marginal systems.

Is Snow Important to Tall Shrubs?

Diana Gilbert (1), Alison Hester (1) & Colin Legg (2)
(1) The Macaulay Institute, Craigiebuckler, Aberdeen AB15 9HA, UK
(2) School of Geosciences, The University of Edinburgh, King's Buildings, Edinburgh, EH9 3JN, UK

High-altitude scrub with willow and other tall-shrub species is rare in Scotland and in decline due primarily to past changes in climate and land management practices [1]. Many of the species are of conservation concern and feature in Habitat or Species Action Plans [2], yet little is known of the current drivers controlling their development and distribution. Manipulative experiments have been set up to examine the effects of exposure, browsing and snow cover on the growth and survival of *Salix myrsinites* L., *Juniperus communis* L., and *Betula nana* L. Potential future changes in snow-lie, such as reduced or less frequent snow cover, are predicted to have significant impacts on high altitude scrub species [3]. In the UK, where snow cover is already highly variable from year to year, it is crucial to gain a better understanding of species responses to changes in snow-lie to be able to develop appropriate conservation management strategies which take this into account. This paper reports on the snow cover experiment. Young plants of all three species were propagated over the winter of 2006/07 and planted out in late summer 2007 at altitudes between 758 m above sea level (asl) and 1036 m asl. For each species cuttings were collected from the east, central and west of Scotland. The young plants were protected from browsing by large mammals in cages (five plants of each species per cage) within the Cairngorm ski resort area (Latitude 57°N) where snow fences gave local variation in snow-lie). Eight pairs of cages were laid out with one of each pair close to a snow fence where snow collects and the other outside the influence of the snow fence (Figure 1). Cages were photographed weekly and snow depth estimated from a 1.5 m graduated pole beside each cage. Prior to planting the following 'baseline' measurements were recorded for every plant: basal diameter, total length, canopy height, maximum canopy diameter and that perpendicular to it, length of all new shoots, and area of the five largest leaves. These will be re-recorded in later summer 2008 and in 2009 together with plant survival and flowering. Temperature has been recorded in every cage at canopy, ground level and at a depth of 10 cm in the soil using Maxim Dallas ibuttons (DS1921G) programmed to record the temperature every two hours. This paper will present the responses of plants and discuss the role of present and future patterns of snow-lie in the ecology and distribution of this community.

Figure 1. Cage close to a snow-fence (top), & its

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In situ quantification of intra-specific functional variability and inclusion in a landscape model

Cécile Albert, Wilfried Thuiller, Sandra Lavorel
Laboratoire d'écologie Alpine, UMR CNRS 5553, Université Joseph Fourier, BP 53, 38041 Grenoble Cedex 9, France

The reality of global changes is nowadays accepted. Land use and climate changes are recognised as the two main drivers influencing the vegetation and the biodiversity. In this context, understand how species behave in different current conditions is essential to predict how they will respond to the coming changes. Then studies along gradients are essential too. If functional attributes of plants are expected to be largely influenced by disturbances and land use (grazing, mowing), the quantification of their variability through direct gradients is lacking. Intraspecific functional variability has been traditionally assumed to be negligible in comparison with interspecific variability. Nevertheless functional variability is now about to be included into landscape or global dynamic vegetation models to make them more realistic. This inclusion is equivalent to replace fixed parameters by functions of the environment. This improvement of models is essential to predict what could happen at trailing edges or at vegetation boundaries, like the alpine tree-line. These boundaries are expected to be particularly sensitive to changes in climate and land-use.

In this study we quantified and expressed the intra-specific functional variability of a set of species in respect to inter specific functional variability. Providing steep gradients and assumed to be particularly sensitive to global warming, alpine systems have been chosen as an ideal study system. We have chosen 13 common species (*Dactylis glomerata, Carex sempervirens, Sesleria caerulea, Festuca paniculata, Geum montanum, Trifolium alpinum, Dryas octopetala, Salix herbacea, Juniperus sibirica, Vaccinium myrtillus, Rhododendron ferrugineum, Larix decidua, Pinus uncinata*) of the Vallée de la Guisane in the French Alps (Hautes Alpes, 05) representing the three dominant life forms. We stratified the landscape according to two orthogonal direct gradients (August solar radiation and winter temperature) and choose between 6 and 18 sites per species, maximising the environmental heterogeneity between sites. In 2007 and for each species, we measured a set of functional traits (leaf nitrogen content, plant height, number and height of flowers, lateral spread, specific leaf area, diameter at breast height, etc.) on 9 individuals per site and some topographic and soil characteristics (pH, organic matter, texture). We also collected data on disturbances like grazing and mowing.

To analyse the results, first we quantified the intra-specific functional variability and determined how much of it is driven by climate, disturbance and soil. Then we compared the species and their functional range to check the negligibility of intra-specific variability in comparison with the inter one. As expected single traits were not describing the plant performance and were not converging. We then explored functional trade-offs of traits with multivariable approaches along environmental gradients.

Finally based on the field work, we also tested the introduction of functional intra-specific variability into a landscape model (LAMOS). In particular we tested this improvement on alpine landscape with a focus on the impact of global changes on the tree-line.

Nutrient limitation at the alpine treeline: elevational patterns in contrasting northern and southern hemisphere forests.

William Mallott (1), David Wardle (2) & Richard Bardgett (1)
(1) Institute of Environmental and Natural Sciences, Lancaster University, Lancaster, UK
(2) Department of Forest Ecology and Management, Faculty of Forest Sciences, Swedish University of Agricultural Sciences, Umeå, Sweden

Alpine treelines are a dominant feature of mountain environments and have been suggested to be an indicator of the impact global change. Whilst climate undoubtedly acts as a major determinant of treeline distribution, nutrient limitation is known to significantly influence plant growth, litter quality and nutrient cycling in alpine and forested systems. We examined patterns of nutrient limitation across elevational gradients in montane forest in the Austrian and Swiss Alps, and in the Southern Alps, New Zealand. Austrian and Swiss treelines are transitional communities (i.e., tree stands become progressively open with increased elevation giving way to krummholz and alpine vegetation), whereas New Zealand treelines form abrupt boundaries [Fig.1]. We used these contrasting forest systems to examine elevational trends in stand biomass, soil nutrient availability, soil microbial biomass, activity and community composition, and plant nutrient status, to assess whether nutrient limitation could influence ecosystem function at the treeline.

The field study provided evidence that feedback effects between above and below-ground communities contribute to nutrient limitation of vegetation and soil biological processes at high elevations, with abrupt reductions in stand biomass and soil nitrogen availability at the treeline. Differences in species distribution (Europe) and trait plasticity within one species (New Zealand) lead to greater resorption of limiting nutrients prior to litterfall in treeline stands relative to those at lower elevations. Consequently, litter quality declines with cascading effects on decomposition and microbial mineralisation of nutrients in treeline soils.

Figure 1: Abrupt alpine treeline (St Arnaud, New Zealand) and transitional treeline with *Pinus mugo* krummholz (Stubai Valley, Austria).

To examine interactions between climate, soil properties and plant traits, a reciprocal soil and litter transplant experiment was carried out across elevational gradients in New Zealand forest. By measuring changes in nutrient cycling and decomposition induced by transplantation we were able to assess the relative influence of climate, soil nutrient availability and shifts in plant traits on these processes. Overall, our findings offer important insights as to how above and below-ground feedbacks may regulate the response of natural ecosystems to global change.

Windthrow and bark beetles as key drivers of hoverfly diversity (Diptera, Syrphidae) in temperate montane forest

Frank Dziock (1), Gisela Merkel-Wallner (2), Reinhard Schopf (3), Jörg Müller (4)
(1) Department of Biodiversity Dynamics, Technische Universität Berlin, Sekr. AB1, Rothenburgstr. 12, D-12165 Berlin, Germany, frank.dziock@tu-berlin.de
(2) Bühläcker 3, D-93444 Bad Kötzting
(3) Lehrstuhl für Tierökologie der TU München-Freising, Am Hochanger 13, D-85354 Freising
(4) Nationalparkverwaltung Bayerischer Wald, Sachgebiet Forschung, Freyunger Str. 2, D-94481 Grafenau

Natural disturbances in forests like windthrows are stochastically recurrent events leading to a drastic change in the amount of open area and dead wood habitats available for forest insects. Windthrow events may also lead to a subsequent outbreak of bark beetle populations, thus enhancing the process of opening up the forest by increasing tree mortality. However, it is far from clear how this feedback loop affects forest biodiversity.

Hoverflies or syrphids are one of the most diverse families of the Diptera and they inhabit virtually every terrestrial and many aquatic ecosystems. The adults visit flowers and feed on pollen and nectar, which makes them the most important pollinators besides bees. The larvae show a broad variety of life styles covering a wide spectrum of resource use, including many different types of old and dead wood habitats. There is sufficiently precise biological data available at the species level to assign species to functional groups for a detailed analysis.

We investigated 36 study plots of 100sqm each in the National Park Bavarian Forest, representing the gradient of altitude, open area and availability of old and dead wood habitats. The sites were chosen randomly from four transects with 300 study plots (Project BIOKLIM), stratified by altitude and amount of open area prior to the random choice. Environmental variables were available from laser scanning data (e.g. mean vegetation height on different spatial scales), field assessments (e.g. amount of dead wood, no. of plant species, age of forest stand, time since bark beetle infestation), and geostatistical modelling (temperature, precipitation, radiation).

RESEARCH QUESTION: How do changes in forest structure caused by windthrow events and (subsequent) bark beetle infestation influence the composition and diversity of forest insect communities – using hoverflies as an example?

Poster presentations

Climate niche-based versus co-occurrence based measurements of ecological specialization in the Alps

Isabelle Boulangeat, Wilfried Thuiller & Sébastien Lavergne
Laboratoire d'ecologie Alpine, UMR CNRS 5553, Université Joseph Fourier, BP 53, 38041 Grenoble Cedex 9, France

In a global change context, and so habitat deletions or modifications, a better understanding of the ecological factors that distinguish specialists from generalists is crucial to estimate species' vulnerability. Indeed, a habitat specialist species is expected to have a stronger response to various changes than a generalist, and will generally be more sensitive to extinction. The French Alps contain a wide range of habitats, species and climates providing an interesting context to investigate the specialization of plants under various environmental conditions.

In this paper, we investigated patterns of plant specialists and generalists using two different approaches ("outlying mean index" and "Fridley index"), and analyzed their repartition in particular habitats, from the local community to the meta-community. We also tested for the existence of phylogenetic conservatism of different specialization indexes and the relationship between specialization and some functional traits. The first approach ("outlying mean index") is based on macro-gradients (e.g. climate variables) which are known to well determine species' repartitions. The second ("Fridley index") is particularly interesting because it is only based on species co-occurrence and makes no hypothesis about the environmental factors controlling species' distribution. We used a remarkable data set comprising 9500 plots of plants communities in the French Alps, with associated habitat information to estimate the specialization index of more than 1600 species.

The different measures of specialization bring complementary information at the community scale and become very similar analysis at the meta-community scale (ie. regional scale). Based on specialization indexes, we demonstrated that a recent evolutionary divergence explains most variance in the degree of specialization, and that overall phylogenetic conservatism in the degree of specialization is low. Some selected traits are also shown to explain a substantial of part of explained variance. We detailed the different implications of the study.

Zooplankton assembles in high-latitude lakes ecosystems of Yakutia (Polar Siberia, Russia)

Larisa Frolova (1), Larisa Nazarovan (2), Ludmila Pestrjakova (3) & Ulrike Herzschuh (2)
(1) Kazan State University, Department of Zoology; Kremlevskaya Str. 18, 420008, Russia
(2) Alfred Wegener Institute for Polar and Marine Research (AWI), Telegrafenberg A 43, 14473 Potsdam
(3) Yakutsk State University, Belinsky str., 58, 364205 Yakutsk, Russia

High-latitude lakes are supposed to be particularly sensitive to environmental changes. Because of small drainage areas, with limited chemical and biological erosion and extreme climatic conditions, they develop simple and labile ecosystems which react promptly to environmental stress. This makes them suited to function as early warning systems.

Very few studies exist on zooplankton composition of freshwater lakes in permafrost area in Yakutia (Polar Russia). It is explained by extremely difficult access to the region on the one hand and a very short-term vegetative period in these latitudes on the other hand. The 35 investigated lakes are situated between 7`15`` and 7`33``N^{o} and 110`82`` to 115`76``E^{o}. The low summer temperatures in the region (mean July air temperature range from 10.2 °C to 12.1°C) have probably influenced the species richness of zooplankton, which is relatively low. The taxa found are generally typical of arctic zooplankton assemblages (*Kellicottia longispina* (Kellicott, 1879), *Cyclops scutifer* (Sars), *Heterocope borealis* (Fischer), *Bosmina longispina* Leydig, 1860). Besides three main groups of zooplankton, in some lakes we have found quite a rare Conchostraca (*Cyzicus tetracerus* (Krynicki, 1830). Copepoda dominates the majority of the lakes. The group constitutes the most of the biomass of zooplankton. Rotatoria dominates in abundance. Although abundance of zooplankton in average is not very high, the predominance of large size zooplankters (*Heterocope*, *Cyclops, Daphnia*) provides in some lakes in July a biomass at the level of oligo-mesotrophic reservoirs.

Trophic structure of the investigated lakes is characterized by high ratio of predators. This is characteristic for the ecosystems with low level of trophy. The invertebrate predator assemblage plays an important role in shallow arctic likes ecosystems that are devoid of fish. Predatory Copepods such as *Heterocope* and various cyclopoids are considered to be most important in structuring arctic zooplankton communities. Absence of any significant anthropogenic influence on lakes ecosystems has allowed us to estimate the majority of the lakes as oligosaprobic, part of the lakes showed features of mesosaprobity. For studying of ecosystems of the Far North more indicative is proved to be index of evenness of Pielou (Pielou, 1966), than index of Shennon- Weaver biodiversity index (Shannon, Weaver, 1963).

The relationship between environmental variables and spatial distribution of individual taxa was tested using canonical correspondence analysis. Variations in lake surface area, maximum water depth, conductivity of the water were less important in controlling the communities composition. However, mean July air temperature and low pH influenced the diversity, abundance and density of some taxa.

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Invertebrate community assembly on nunataks, Iceland

María Ingimarsdóttir (1,2) & Katarina Hedlund (1)
(1) Department of Ecology, Lund University, Sölvegatan 37, SE-22362 Lund, Sweden
(2) Icelandic Institute of Natural History, Hlemmur 3, IS-105 Reykjavík, Iceland

For the last decades we have been facing a period of global warming. As a consequence glaciers have been melting and when a glacier melts it does not only retreat but also becomes thinner. Tops of mountains emerge through the glacier and form ice free islands, so called nunataks. Nunataks provide excellent locations for studies on primary succession and assembly of communities. Primary succession of vegetation has been studied worldwide but the primary community assembly of invertebrates has recieved less attention. The invertebrate community assembly on nunataks is a process that so far is not known.

The glacier Breiðamerkurjökull in SE-Iceland has three nunataks of known age that have emerged during the last 70 years: Kárasker around 1935, Bræðrasker 1961 and Maríusker 2000. It also has old nunataks, Esjufjöll. All the nunataks have been getting larger as the glacier has retreated.

In the summer of 2008 we will study the dispersal and colonization of invertebrates in this area. Dispersal abilities of invertebrates over the glacier will be studied with the use of sticky traps and by comparing those with traps on the glacier foreland it will be possible to determine whether the glacier is a barrier for invertebrate dispersal. To study colonization processes we will collect invertebrates by pitfall traps and soil samples on land of different ages in each nunatak. The community assembly on the nuntaks will be determined for the dominant invertebrate groups.

Succession of the carabid beetles population during the reforestation of the sand quarriers in the North-West Siberian taiga

Ilya I. Lyubechanskii
Institute of Systematics and Ecology of Animals, Frunze str., 11, Novosibirsk, 630090, Russia
E-mail: lubech@rambler.ru

The anthropogenically disturbed biotopes are widely distributed in the taiga of North-West Siberia as a result of growing oil and gas mining. Most of these changes are caused by the formation of the infrastructure elements (mining places, roads, etc.). These objects take huge amounts of sand from numerous sand quarriers situated nearby.

We studied the ground beetle (Coleoptera, Carabidae) fauna and population during the succession on the abandoned sand quarriers of different age (from 1 to 20 years old), and compared them with those of native biotopes (bogs and pine forests). The study area situated near Noyabrsk city (63° 15' N, 74° 30' E). 21 sites were investigated from 1999 to 2002. 54 carabid beetle species were collected by pitfall trapping. We found 39 species in anthropogenic sites and 27 species in native ones. Most species belonged to the genus *Bembidion* (13 sp.), *Pterostichus* (8 sp.), *Agonum* (5 sp.). The species richness and density in anthropogenic habitats was usually higher then in the native ones. We compared the zoogeographic features of the anthropogenic and native fauna. The 4-fold decrease of the arctoboreal species rate takes place in the quarriers (from 8 to 3 species). Carabid species of taiga and tundra can not occupy these habitats because the temperature of the open ground is higher than that under the trees. The number of the west-palearctic species increases in anthropogenic biotopes (almost 3-fold: from 5 to 14 species), and the number of the east-palearctic species decreases (5-fold). Central-palearctic species are disappearing in the places of sand. The reason is that the east- and central-palearctic carabid species from the study site are inhabitants of mire and boreal landscapes and can't survive in destroyed landscapes. On the contrary, west-palearctic species in the boreal zone are associated with intrazonal landscapes. By this (and by their good ability for flight), such species can easily colonize disturbed places. All the studied sites could be divided into 3 groups according their carabid population. 1) Coasts of small lakes in quarriers, where typical riparian carabids live: *Elaphrus riparius*, *E. sibiricus*. 2) All other types of the disturbed habitats: quarriers and burnt places 7-10 yr. old. These habitats are occupied by most warm- and dry-preferred species: *Cicindela silvatica*, *Poecilus lepidus*, *Dicheirotrichus cognatus, Microlestes schroederi*, some *Harpalus* and *Cymindis* species; and most abundant *Amara quenseli.* Quarriers of the same age have the similar carabid population. 3) Different kinds of undisturbed habitats. Arctic and boreal carabid species are inhabit these sites, such are *Pterostichus brevicornis, P. parens, Carabus nitens*. We studied the succession on the abandoned quarrier from 1999 (one yr. old) to 2002. Main species of carabids are invade such places on the 2nd year (may be, more early). The dynamic density achieves 18-25 specimens per 100 trap-days during the 2nd year after abandoning. At the 3rd year the density rised to 54 specimens per 100 trap-days and don't increased after that. Such values were the same as in another young quarrier 5-8 yr. old. The number of species during 1-3 yr. is about 5-6, and at the 4th year increases to 11 (another young quarrier – 9 species). **Abstract absolutely too long/cut**

A new Rain Simulator for a better understanding of the origin of surface runoff in Alpine Landscapes

Christian Newesely (1), Georg Leitinger (1), Erich Tasser (2), Werner Zimmerhofer (1), Ulrike Tappeiner (1,2)*
(1) University of Innsbruck, Institute of Ecology, Austria
(2) European Academy Bolzano, Institute for Alpine Environment, Italy
**christian.newesely@uibk.ac.at*

Alpine areas are highly sensitive to land-use and climate changes which can result in a shift in biodiversity. So far, detailed information on attached processes is still missing. Although surface runoff is known for enhancing wet land slide and erosions we still do not understand the underlying factors. The present rain simulator will help to better comprehend the formation of surface runoff. Using tubes and three different types of nozzles (full, half and quarter circle) we constructed a rain simulator for the irrigation of 10 m². Arrangement of nozzle-types and their resulting sprinkling scheme for as uniform water application as possible is shown in Figure 1. Irrigated water quantities are automatically registered with a logger connected to a water meter and by changing the water pressure, the rain intensity can be modified from 70 to 100 mm h-1. The runoff water is thereafter caught in a cannel and measured in intervals of 1 minute. Our standard irrigation time is one hour.

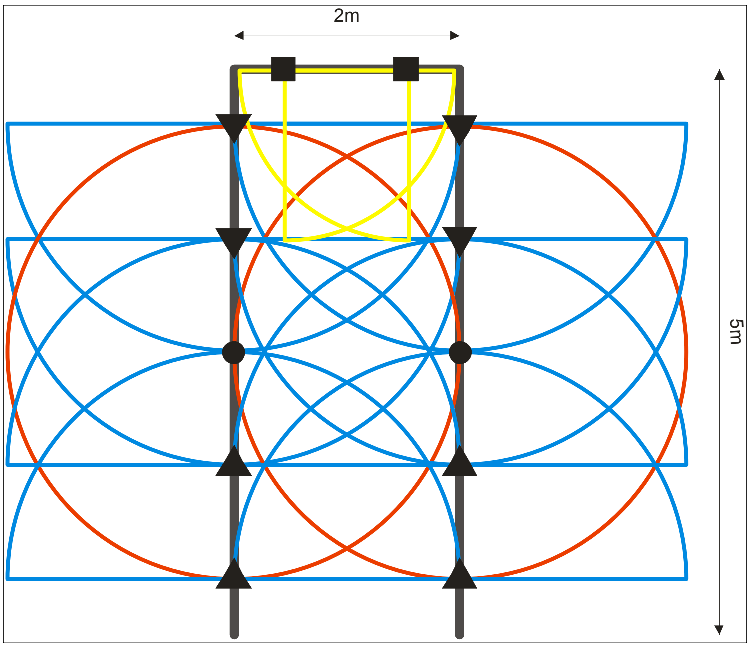

Figure 1: Sprinkling scheme of the rain simulator (nozzle symbols: circle / red = full, triangle / blue = half, square / yellow – quarter circle)

Changes in vegetation phenology under climate change in high alpine ecosystems

Anja Rammig (1), Tobias Jonas (2), Christian Rixen (2)
(1) Potsdam Institute for Climate Impact Research (PIK), Telegraphenberg A62, P.O. Box 60 12 03, D-14412 Potsdam, Germany
(2) SLF, Swiss Federal Institute for Snow and Avalanche Research, Flüelastr.1, CH-7260 Davos, Switzerland

High alpine shrub- and grasslands above treeline are characterized by long-lasting snow cover, a short vegetation period and extreme climatic conditions. In these ecosystems, climate change will probably strongly affect plant phenology and growth due to increased temperatures and a prolonged growing season. In a unique experiment, climatology and plant growth was monitored for almost a decade at 17 snow meteorological stations in different alpine regions along the Swiss Alps. Using linear regression models, we found that the average May/June temperature was significantly related to the date of snow melt-out, begin of plant growth and plant height. To project the changes in melt-out, begin of growth and plant height for future climate conditions, we applied the regression models to climate data from different climate models (e.g. Hadley, PCM) and IPCC-SRES scenarios (A1, A2, B2). Under these simulated future climate conditions, melt-out and onset of growth was predicted to occur about 7-30 days earlier by the end of the century than in the control period from 1971-2003. Plant biomass increased by 18 to 47%. These results give first estimates of the extent of climate change impacts on alpine plant communities. In particular, warmer spring temperatures and subsequent earlier melt-out dates may cause a considerable shift towards faster growing plants.

Intra-annual cambium dynamics of northern boreal Scots pine in relation to climate

Jeong-Wook Seo (1), Dieter Eckstein (1), Risto Jalkanen (2), Uwe Schmit (3), Jörg Fromm (1)*
(1) Univ. of Hamburg, Dept. of Wood Science, Div. Wood Biology, 21031 Hamburg, Germany
(2) Finnish Forest Research Institute, Rovaniemi Research Unit, 96301 Rovaniemi, Finland
(3) Federal Research Institute for Rural Areas, Forestry and Fisheries, 21031 Hamburg, Germany
** Corresponding author: e-mail j.seo@holz.uni-hamburg.de*

The cambium of trees in boreal forests, known to be mainly positively related with summer temperature, transforms climatic information into the amount of wood, which can thus retrospectively be used as a biological indicator for environmental changes. Since recent years, however, it has been repeatedly observed that summer temperature does not always positively influence the cambium activity.

The intra-annual cambium dynamics of Scots pine at two sites, approx. 200 km apart from each other, close to the northern forest border was monitored from 2000 to 2004 and compared with the contemporaneous temperature. The trees at the southern site were mainly positively and at the northern site mainly negatively correlated with summer temperature. Regardless of it and whether the growing season started earlier or later, at both sites two-third of the annual radial growth was produced within four weeks from mid-June to mid-July.

In view of climate change, it might be possible that trees near their northern distribution border do not always profit from the warming trend but start to get impaired from an increasing moisture deficit.

Molecular analysis of trophic interactions in alpine pioneer communities

Daniela Sint, Lorna Raso, Ruediger Kaufmann & Michael Traugott
Institute of Ecology, University of Innsbruck, Technikerstr. 25, 6020 Innsbruck, Austria
Email: daniela.sint@uibk.ac.at

The dramatic retreat of the glaciers over the last 150 years is one of the evident signs of climate change in alpine landscapes. Because of their relative simplicity, glacier forelands are model systems for investigating fundamental ecological processes such as colonization, population establishment and community assembly. Interestingly, early successional stages of primary successions are dominated by predatory coloniser communities [1], and although the rather simple faunal pioneer communities are characterised quite well, we still do not understand on which trophic interactions community assembly depends. This project, conducted in three glacier forelands in the Ötztaler Alpen (Austria), directly addresses this lack of knowledge.

Two principal aims will be addressed:

- Resolving trophic linking within macro-invertebrate communities colonizing recently deglaciated alpine terrain using a molecular approach.
- Comparing macro-invertebrate food webs between early and late pioneer stages.

By employing the latest approaches in molecular prey detection [2] and merging these data with a comprehensive analysis on community composition, semi-quantitative food webs will be created [3] (Figure 1). These webs will depict trophic linking in terrestrial invertebrate communities at an entirely new level of resolution.

The outcome from this study will take research on glacier forelands and primary succession one step further, as it will not only describe changes in invertebrate community structure but focus on a key functional aspect, trophic linking, within animal pioneer communities.

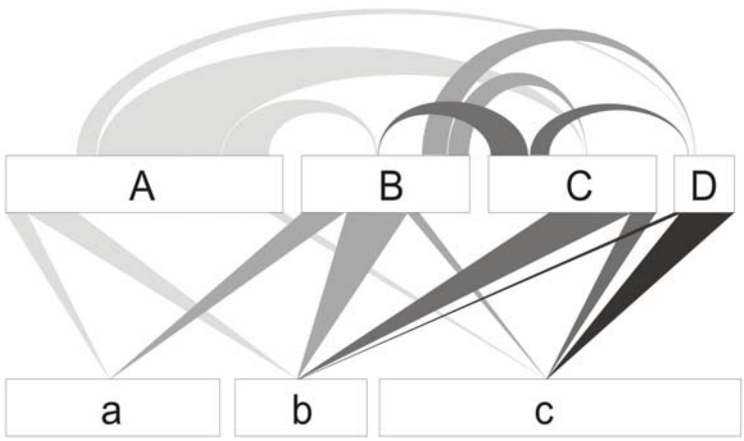

Figure 1: Hypothetical semi-quantitative food web. Capital letters represent predatory species; lower case letters different prey species. Bar widths reflect the species' abundances, links show trophic interactions between species and width of the link indicator (at the base of the consumer) reflect the strength of trophic connections.

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Impact of global change on biodiversity and biogeochemical cycles

1.2.Biogeochemical cycles of terrestrial ecosystems in a changing environment

Michael Bahn, Ansgar Kahmen, Alexander Knohl, Werner L. Kutsch

Oral presentations

Functional significance of biological diversity under global change

Christian Körner
Institute of Botany, University of Basel, Schönbeinstrasse 6, CH-4056 Basel, Switzerland

At the dawn of global change science, ecosystem responses to atmospheric change were considered a direct consequence of physiological baseline responses of plants. More CO_2 in the atmosphere does stimulate leaf photosynthesis, this in turn was assumed to cause more plant growth, which was further taken as a surrogate of net primary production, NPP. Implicitly NPP was treated as carbon sequestration. While such a chain reaction in itself lacks supporting evidence, it was further assumed that the green cover of the planet would respond uniformly, or, at the least that plant responses within certain plant functional groups would be similar. Now, after more than three decades of exploring this field, it became evident that neither the theory-based cascade of carbon uptake events, nor 'big leaf' models of ecosystems, or projections based on plant functional types are matching reality. NPP and carbon sequestration are often negatively correlated (over large areas and time scales), and species presence/absence turned out to be decisive for ecosystem processes. This overview will focus on carbon relations in a CO_2-rich world.

I will present examples from elevated CO_2 research in grassland, temperate and tropical forests in order to underpin the significance of species identity. Among the important insights, it became evident that legumes do not respond as a uniform group, CO_2-driven changes in water relations mimic changes in carbon relations and soil conditions determine which species take advantage of enhanced photoassimilate availability and which not. Future research needs to account for biodiversity effects for arriving at trustworthy projections of the consequences of ongoing atmospheric CO_2 enrichment.

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10 years of Free Air Carbon dioxide Enrichment (FACE) on grassland: Are there long-term effects on soil C pools and the ecosystem trace gas balance?

Lenhart K., Kammann C., Grünhage, L., Jäger H.-J.
Justus-Liebig-University, Department of Plant Ecology, Heinrich-Buff Ring26-32, 35392 Gießen, Germany

Increasing the soil C stocks is of major interest to mitigate the rise in atmospheric CO2-concentration and therefore global warming, although evidence for a CO2-induced increase in soil C pools is limited and the results are rather inconsistent ([1], [2],[3]). However, as step-increase effects at the beginning of a CO2-enrichment experiment may alter the ecosystem responses to elevated CO2, long term studies are needed to make reliable predictions. In this study we examined the effects of elevated CO2 on C sequestration and the greenhouse gas (GHG) balance of CO2, N2O and CH4 over a period of 10 years.

The Gießen-FACE experiment started in May 1998 with a year-round CO2-enrichment of +20 % above ambient, i.e. 440 ppm. The δ13C signature difference applied with the enrichment-CO2 was used to calculate the C-input under elevated CO2. Trace gas measurements started in 1997 via closed-chamber technique with two measurements per week since that time.

Between 1998 and 2006 the soil C input corresponded to 93.5 g C m-2 yr-1 in the soil profile (45 cm). However, no CO2-induced net increase in the soil C pools occurred in any depth. Over the whole period, elevated CO2 increased N2O emissions about x % compared to ambient, CH4 oxidation was reduced by x %. Theoretically, simply to offset the additional N2O emissions (i.e. x g m-2 yr-1), x kg C m-2 yr-1 must be additionally sequestered every year. Besides the absence of an increase in the soil C pool under elevated CO2 in this study, there is evidence that the amount of C that can be stored in the soil is limited [4].

Therefore, the capability of (grassland) ecosystems to reduced GHG and thereby counteract global warming may be limited. Likely, some ecosystems that are predicted to act as a net CO2-sink in the future will become a net GHG source when taking into account the CO2-induced changes in the fluxes of N2O and CH4.

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Substantial carbon losses from subalpine grassland suggested by CO2-fluxes under high nitrogen and ozone deposition

Matthias Volk (1), Kris Novak (2), Daniel Obrist (3), Robin Giger (1), Seraina Bassin (1), Jürg Fuhrer (1)
(1) Agroscope ART Reckenholz, Swiss Federal Research Station for Agroecology and Agriculture Air,Pollution/Climate Group Reckenholzstrasse 191, CH-8046 Zurich, Switzerland
(2) National Center for Environmental Assessment, U.S. Environmental Protection Agency, 109 TW Alexander Dr,. Research Triangle Park, NC 27711
(3) Desert Research Institute, Division of Atmospheric Sciences, 2215 Raggio Parkway, Reno, NV 89512

Effects of increasing levels of atmospheric O_3 and N deposition on grasslands are largely unknown. This comes from a lack of studies with experimental applications of these pollutants under natural, on site conditions. Thus we established such a longterm experiment on a subalpine pasture at 2000m asl.

In the study presented here, we assessed effects of increased atmospheric ozone concentrations (3 levels: ambient, amb. * 1.2 and amb. * 1.6) and increased nitrogen deposition (3 levels: ambient, amb. + 10 kg ha^{-1} a^{-1}, amb. + 50 kg ha^{-1} a^{-1}) during the third year of the experiment. During ten days and 13 nights, covering the vegetation period of the year 2006, ecosystem-level CO_2 exchange of intact monoliths of the subalpine grassland ecosystem was measured. We were using a 30 * 40 * 35 cm large, static cuvette of transparent polyacrylics. All gas exchange responses to the fully factorial treatment combination were analysed in a split-plot repeated measures ANOVA. Light dependency of CO_2 exchange was established and soil temperature, soil water content (SWC) and solar radiation were monitored.

Ecosystem respiration (R_{eco}) was found to be slightly increased under high N and decreased under high O_3 compared to control throughout the season. Similarly, whole season gross primary production (GPP) was slightly decreased both under high N and high O_3 compared to control. Neither the responses to high ozone nor to nitrogen deposition caused significant effects. There was no interaction between the two treatments.

To assess the cumulative seasonal effect of the small differences found in our spot measurements, we were using R_{eco} and GPP measurements to model net primary productivity (NPP) as seasonal CO_2 exchange, based on hourly averages of global radiation and soil temperature. Grassland plots of all treatment combinations had a negative NPP. But the high nitrogen deposition treatment yielded a *c.* 50 g m^{-2} larger carbon loss compared to control and other treatments.

In addition, we observed a highly significant one third increase of aboveground productivity in the high N deposition treatment. High O_3 reduced dry matter yield only marginally.

At the present state of the experiment O_3 effects remain unsuspicious. But under increased nitrogen deposition, R_{eco} results in carbon losses that are more than three times larger than the aboveground carbon gains observed at the same time.

The fate of C in adult beech and spruce trees after seven years under elevated ozone

Thorsten E. E. Grams (1), Wilma Ritter (1), Rainer Matyssek (1) & Christian P. Andersen (2)
(1) Technische Universität München, Ecophysiology of Plants; Am Hochanger 13, 85354 Freising, Germany
(2) US Environmental Protection Agency, Western Ecology Division, 200 SW 35th St., Corvallis, OR 97333; USA

Half of the carbon (C) fixed by forest trees is released back to the atmosphere within a couple of days via respiration. However, our knowledge about the use of recently fixed C by respiration in plant organs (e.g. leaves, stems, roots) and in the soil is still limited.

The present paper investigated this question in 60 year old trees which are readily accessible via scaffolding and canopy crane. Atmospheric CO2 was isotopically labeled by a novel CO2 exposure system (tubeFACE) using 13C depleted CO2 at canopy level. The study takes advantage of a unique 7-year O3-FACE experiment on adult European beech (Fagus sylvatica) and Norway spruce (Picea abies) trees, to investigate changes in C allocation cause by O3 exposure. We hypothesized that belowground C allocation of both species is reduced under long-term O3 treatment (cf. [1]).

Results from adult trees are cross-compared with investigations on juvenile trees grown in the phytotrons of the Helmholtz Zentrum München - German Research Center for Environmental Health with a well established competitive setup of 20 beech and/or spruce trees grown together within same soil container systems ([2], [3]).

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Conifer cold hardiness, climate change and the likely effects of increased air temperature on photosynthesis

Ingo Ensminger (1,2), Florian Busch (2,3), Lilian Schmid (3), Sebastien Caron (4), Laurentiu A Tarca (5), Jon Lloyd (6), John MacKay (4), Norm PA Huner (2)
(1) Forest Research Institute of Baden-Württemberg,79100 Freiburg i. Br., Germany, ingo.ensminger@forst.bwl.de
(2) Department of Biology and The BIOTRON, University of Western Ontario, London, ON N6A 5B7, Canada
(3) Institute of Chemistry and Dynamics of the Geosphere, Forschungszentrum Jülich, 52425 Jülich, Germany
(4) Centre d'étude de la forêt (Cef), Université Laval, Québec, QC G1K 7P4, Canada
(5) NIH-Perinatology Research Branch, Wayne State University, Detroit, MI 48201, USA
(6) School of Geography, University of Leeds, Leeds, LS2 9JT, UK

During winter and early spring, evergreen boreal conifers are severely stressed because light energy cannot be used when photosynthesis is pre-empted by low ambient temperatures. As the climate warms over the coming century, an increased length of the growing season for boreal forest trees is predicted, thereby altering the carbon sink of conifer forests. Some of these forests might also be negatively affected by increased land surface air temperatures, due to e.g. the disruption of regulatory processes and hence an incomplete exploitation of the increased length of the growing season. To isolate the effect of temperature from the cellular to the ecosystem level, we studied the dynamics of photosynthesis under boreal climate conditions in the field as well as in controlled experiments in phytotrons. While photosynthesis of many species has a positive response to temperature, recent findings suggests that photoperiod control of dormancy in pine during autumn appears to negate any potential for an increased carbon gain associated with higher temperatures during the autumn season. By contrast, the onset of CO2 assimilation in spring is clearly triggered by increasing air temperatures, however, low soil temperatures and intermittent frost can decrease the rate of the photosynthetic spring recovery process in conifers. We conclude that adaptation of photosynthesis to varying temperatures revolves around the trade-off between utilizing the full growing season and minimizing damage (frost, oxidative stress) through proper timing of hardening in autumn and dehardening in spring.

The effect of soil temperature manipulation on leaf physiological traits in 200 year old oaks

Onno Muller (1,2), Masahiro Nakamura (1) , Kouki Hikosaka (2) & Tsutom Hiura (1)
(1) Tomakomai Research Station, Field Science Center for Northern Biosphere, Hokkaido University, Tomakomai 053-0035, Japan
(2) Graduate School of Life Sciences, Tohoku University, Aoba, Sendai 980-8578, Japan

Models predict that the mean global temperature will increase 1.4-5.8°C during the next century (IPCC). Photosynthesis of canopy leaves is a major determinant of the global carbon cycle [1,2] and photosynthesis is strongly dependent on temperature (e.g. [3]). However due to practical limitations at a canopy level, i.e. in mature trees, the effect of global warming has seldom been measured. We studied the response of global warming on leaf physiological traits in the canopy by warming up the soil around mature trees. We studied a mature, deciduous broad-leaved forest stand in the Tomakomai Experimental Forest, Hokkaido, Japan (TOEF; 42°40′ N,141°36′ E) [4]. We selected 8 canopy trees of Quercus crispula (around 20 m in height) at the canopy crane site in TOEF. For 4 trees in a 5x5 m area around the trunk heating cables were dug into the soil and the soil was warmed up to 5 degrees above control soil temperature from spring 2007. Photosynthetic rates were measured with an open gas exchange system in a 3x2cm chamber (LI-6400, Li-Cor). Photosynthetic capacity (saturated light, 370 ppm CO2) and respiration at 20°C measurements were made on June 19-20, July 17-18, August 20–22 and September 9-10 and 25-26 in 2007 and will be measured at the same interval in 2008. We used attached unshaded leaves. Afterwards 3 leaf punches were punched out per leaf, oven dried and analyzed with a NC analyzer (Vario EL III, Elementar). Over the year the photosynthetic capacity (Pmax), stomatal conductance (gs), intercellular CO2 concentration (Ci),leaf mass per area (LMA), leaf nitrogen content per area (Narea) and per mass (Nmass) were highest in August or the beginning of September and the respiration was highest in June. The annual physiological traits dynamics were similar to previous research on Q.crispula [5]. The increase in soil temperature did not alter the photosynthetic rates over the year. However the Ci , Narea and Nmass were lower in the treatment trees. This resulted in a higher photosynthetic nitrogen use efficiency (PNUE) in the warmed up trees. We will study if this trend continues in 2008 and what leads to an increase in PNUE and its effect at the canopy level. We will further discuss and present the results of 2007 and 2008.

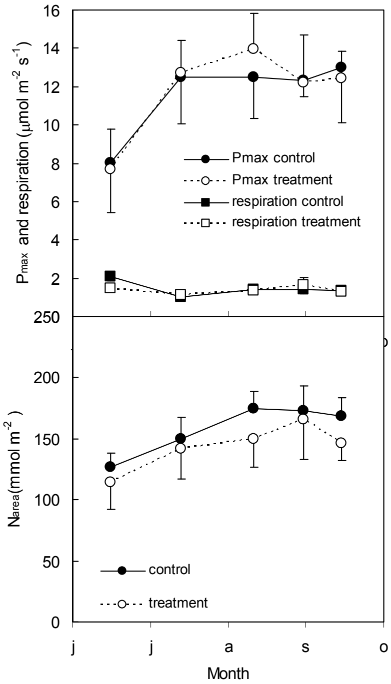

Fig. 1 P_{max} and respiration (a) and N_{area} (b) from June to September 2007. The mean ± SD of 4 trees per treatment (+ 5°C soil warming) and control is shown.

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The influence of hydraulic limitation on growth and carbon supply of tall ponderosa pines

G. Hoch (1) and A. Sala (2)
(1) Botanisches Institut, Universität Basel, Schönbeinstrasse 6, 4056 Basel, Switzerland
guenter.hoch@unibas.ch
(2) Division of Biological Sciences, University of Montana, USA

Trees are the tallest living organisms on earth, with some species reaching maximum heights of more than 100 m. In addition to the obvious biomechanical challenges that tall trees face, increases in tree height are also associated with constraints on long distance transport processes, of which hydraulic constraints have received much attention over the last decade. As trees grow taller the resistance to water movement from roots to leaves increases. To prevent cavitation, tall trees close stomata to a larger degree than shorter trees, thereby causing a reduction of photosynthesis, and, presumably, growth. Originally proposed by Ryan and Yoder [1], this hydraulic limitation hypothesis (HLH) aims to explain the age-related decrease in productivity in stands and individual trees. However, despite a commonly reported cascade of hydraulic constraints - reduced gas exchange - declined photo-assimilation, no evidence so far supports the hypothesis that reduced photosynthetic activity in tall trees is indeed responsible for reduced tree growth [2]. Such lack of evidence suggests that C availability may not limit growth in tall trees. To elucidate a possible C-limitation of tall trees, we measured stored mobile carbon pools (starch, low molecular weight sugars, lipids) in leaves, branches and bole sapwood of ponderosa pines (Pinus ponderosa) of different heights at two sites differing in water availability in western Montana, USA. At both sites, trees showed a strong decline of basal area growth efficiency with increasing tree height, and a trend of reduced volume growth efficiency from height class 15-20 m to height class 35-40 m, especially at the drier site. In contrast to the predictions of the HLH, however, the size of the mobile carbon pools largely increased in the tallest height classes, indicating rather an overabundant C-supply than a shortage of photo-assimilates in the tallest trees. Additionally, the increase of mobile carbon stores with tree height was more pronounced at the drier site. Depending on tissue and site, non-structural carbohydrates (NSC) increased from the smallest to the tallest tree height class by 25 to 140 %, with the strongest effect in young branch sapwood. Like NSC, lipid concentrations were markedly higher in the tallest height class in branch sapwood at both sites. The only exception to this general pattern was found for lipids of bole sapwood, which decreased moderately (by about 20 % compared to the smallest height class) in the tallest trees. However, this decline might be due to an age-dependent change in the proportion of polar (structural) to neutral (storage) lipids, which was not analyzed within this study, and which therefore might not be related to a reduced C-storage pool per se. Hence, we propose that C-limitation due to increasing hydraulic constraints is unlikely to explain the observed decline of growth efficiency in tall trees.

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Are browsed Betula pubescens trees carbon-limited?

Sara Palacio, Alison Hester & Peter Millard
Macaulay Institute, Craigiebuckler AB15 8QH, Aberdeen, UK.

Browsing inhibits regeneration of native woodlands worldwide [1]. A direct consequence of browsing during late spring or summer is a decrease in leaf area, leading to a reduction in photosynthesis. Therefore, it has been suggested that a carbon (C) limitation is the cause of reduced tree growth after browsing [2]. This may have consequences for the potential of browsed trees to sequester atmospheric C [3]. However, data from long-term studies are lacking.

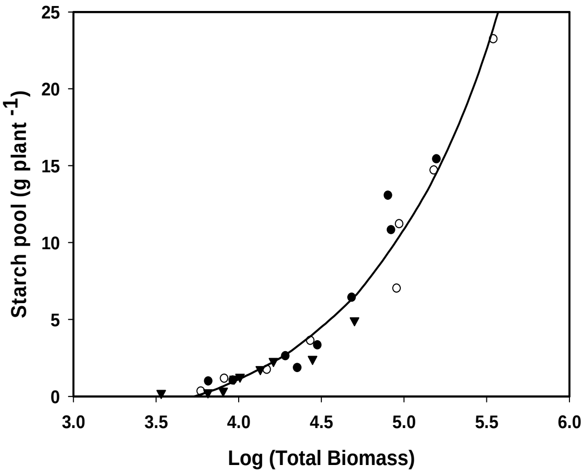

Fig. 1. Relationship between starch pool in the coarse roots and main stems of *B. pubescens* (g plant-1) and the logarithm of the total plant biomass. Different symbols indicate different long-term clipping treatments: control (●); 33% of current year's shoots removed (○); and 66% of current year's shoots removed (▼). Data points were fitted to an exponential curve with the equation: y = -2.70 + 0.0233 (3.566 ^{x}); R^2 = 0.95, P < 0.001.

To determine if repeated summer browsing causes a C source (photosynthetic) limitation in trees, we analysed the non-structural carbohydrate (NSC) and nitrogen (N) concentrations and pools of *Betula pubescens* Ehrh. saplings subjected to different annual treatments (unclipped, 33% and 66% shoot removal) for 7 years. The short-term effect of browsing on C allocation was also assessed by clipping trees with different browsing histories and analyzing their C and N responses within the same growing season. The hypotheses were that: (i) repeated summer browsing would cause a C source limitation in trees, seen as decreased C partitioning to starch and (ii) the NSC pools of trees subjected to a more intense summer browsing regime would be smaller and more severely affected a single browsing event.

Repeated summer clipping significantly decreased sapling growth and soluble sugar (SS) concentrations in fine roots. However, the relationship between starch pool size and total tree biomass was not significantly different between long-term clipping treatments (Fig 1), and hence there was no treatment effect on the C partitioning to starch. Finally, simulated browsing decreased the NSC pools of main stems and the C and N pools of the fractions removed by clipping in the short-term.

We conclude that summer clipping can decrease C pools in the short but not in the long-term. Trees are able to compensate for C losses derived from browsing, so that repetitive summer clipping performed over 7 years does not change the C partitioning of *B. pubescens* trees growing in the wild. Altogether, our results support the view that trees are not C (source) limited.

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Ecosystem-level water-use efficiency inferred from eddy covariance data: definitions, patterns and spatial up-scaling

Markus Reichstein, Christian Beer
Max Planck Institute for Biogeochemistry, Hans-Knöll-Str. 10, DE-07745 Jena, Germany

In this presentation we discuss ways to infer and to interpret water-use efficiency at ecosystem level (WUEe) from eddy covariance flux data and possibilities for scaling these patterns to regional and continental scale. In particular we convey that:

WUEe may be computed as a ratio of integrated fluxes or as the slope of carbon versus water fluxes offering different chances for interpretation. If computed from net ecosystem exchange and evapotranspiration on has to take of counfounding effects of respiration and soil evaporation.

WUEe time-series at diurnal and seasonal scale is a valuable ecosystem physiological diagnostic for example about ecosystem-level responses to drought. Most often WUEe decreases during dry periods.

The mean growing season ecosystem water-use efficiency of gross carbon uptake (WUEGPP) is highest in temperate broad-leaved deciduous forests, followed by temperate mixed forests, temperate evergreen conifers, Mediterranean broad-leaved deciduous forests, Mediterranean broad-leaved evergreen forests and Mediterranean evergreen conifers and boreal, grassland and tundra ecosystems.

Water-use efficiency exhibits a temporally quite conservative relation with atmospheric water vapor pressure deficit (VPD) that is modified between sites by leaf area index (LAI) and soil quality, such that WUEe increases with LAI and soil water holding capacity which is related to texture.

This property and tight coupling between carbon and water cycles is used to estimate catchment-scale water-use efficiency and primary productivity by integration of space-borne earth observation and river discharge data.

Long-term temporal variation in carbon-water interactions in a Scots pine forest

Ivan Janssen & Bert Gielen
University of Antwerp, Research Group of Plant and Vegetation Ecology; Universiteitsplein 1, B-2610 Wilrijk, Belgium

In this paper, we will present an original analysis of a 10-year-long continuous data set of carbon- and water balance estimates, constructed mainly via direct measurements, and complemented with fluxes derived from a process-based ecosystem model. During this time series climatic variability was very large, including several pronounced drought- and/or heat waves, as well as inundations caused by extreme rain events. The large climatic variability thus resulted in a wide range of soil water – and oxygen availabilities, which must have affected plant- and microbial functioning.

The paper will assess the interactions between water availability and carbon inputs, respiratory carbon losses, and carbon losses via leaching of dissolved organic carbon (DOC). For the carbon inputs, we will determine the relationship between the anomalies of gross primary productivity (GPP) and those in climate. We will also test how water use efficiency (GPP / transpiration) is affected by soil water extremes and temperature.

For the carbon losses, we will analyze time series of measured ecosystem- and soil- respiration to determine when – and how intense the Birch effect occurs, how drought influences the temperature responses, and last determine how flooding influences the respiratory rates. In the last section, we will present the time series of DOC leaching and determine the main drivers of this often-ignored carbon loss.

Response of forest ecosystem fluxes and feedbacks to the atmosphere during droughts of various degrees in the years 2000 to 2006

Alexander Knohl (1,2), Werner L. Kutsch (2), Martina Mund (2), Corinna Rebmann (2), Olaf Kolle (2), Ernst-Detlef Schulze (2)
(1) Institute of Plant Science, ETH Zürich, Universitätstrasse 2, 8092 Zürich, Switzerland
(2) Max Planck Institute for Biogeochemistry, PO Box 100164, 07701 Jena, Germany

Extreme climate events such as droughts are expected to increase in intensity and frequency even in temperate regions, but the extent to which such events will impact terrestrial ecosystems in their physiological functions and their feedbacks to the atmosphere remains unclear. Based on continuous eddy covariance measurements at a deciduous beech forest in Central Germany, we asses how carbon dioxide, water vapor and energy fluxes respond to droughts of various intensities during the years 2000 to 2006.

We found a substantial decrease in net carbon uptake during the peak of the drought in summer 2003 and in July 2006 which was mainly driven by soil water shortage rather than by temperature excess. Plants were able to maintain fairly constant ecosystem response functions to environmental parameters only for well-watered conditions (relative plant available soil water > 0.45). Below this threshold light-saturated carbon uptake (Amax) as well as the sensitivity of canopy conductance to leaf-to-air vapor pressure gradient (D0) decreased sharply by up to 70% and recovered only with the first precipitation. Leaf gas exchange measurements revealed that the decline in ecosystem scale carbon uptake was caused by a decline in both, stomatal conductance as well as in photosynthetic capacity.

Intrinsic water-use-efficiency as approximated by the product of water-use-efficiency (GPP/ET) times leaf-to-air vapor pressure deficit (DL) increased below the soil water threshold elucidating the close coupling of the carbon and water cycle. The reductions in canopy conduction strongly decreased ecosystem evapotranspiration. Since incoming radiation remained high during drought, this caused an unprecedented increase in sensible heat fluxes. During drought the ecosystem operated as a substantial source of heat to the atmosphere potentially causing important biosphere-atmosphere feedbacks.

Partitioning ecosystem carbon fluxes: Disentangling temporal dynamics of all major component fluxes in a Mediterranean ecosystem

Stephan Unger (1), Cristina Maguas (2), Joao S.Pereira (3), Teresa S. David (4), Luis Aires (5) & Cchristiane Werner (1)
(1) Exp. and Systems Ecology, University of Bielefeld, Germany, (sunger_19 @yahoo.de; Fax: +49-521-1066038/Tel: +49-521-1065572
(2) Centro de Ecologia e Biologia Vegetal, Universidade Lisboa, Portugal
(3) Instituto Superior de Agronomia, Universidade Técnica de Lisboa, Portugal
(4) Estação Florestal Nacional, Oeiras, Portugal
(5) Departamento de Ambiente e Ordenamento, Universidade de Aveiro, Portugal

Ecosystem respiration (Reco) is one of the major determinants of carbon balance in most terrestrial ecosystems. Thus, a thorough understanding of processes driving respiration and its isotopic composition is of major interest. Partitioning ecosystem respiration into its component fluxes (e.g. Rsoil, Rroot, Rleaf) provides an important tool to disentangle these processes.

We used a high-time resolved mass balance approach combining both respiration fluxes (ecoflux approach) and their isotopic signatures (eco-isoflux approach) to partition carbon fluxes of a Mediterranean ecosystem into all major component fluxes during a spring to summer transition period.

First, both models have the potential to successfully partition soil and ecosystem carbon fluxes into their assimilatory and respiratory components. They provide the possibility to directly access the different responses in isotopic carbon fluxes to changes in abiotic drivers. So far the keeling plot approach is the only way to determine isotopic composition of ecosystem respiration (δ13CR). However, small CO2 gradients owing to low respiratory activity or strong vertical mixing often impede the calculation of significant keeling plot regressions. Our results indicate the eco-isoflux model as a powerful alternative tool to bottom-up model δ13CR during times when sufficient CO2 gradients for keeling plots are difficult to capture.

Second, a straight-forward Intube-incubation approach in combination with the Keeling plot method enabled high-time resolved measurements of respiratory δ13C of all major ecosystem components (roots, soils, foliage). We found large short-term variations in isotopic composition of CO2 respired (δ13Cres) from foliage and roots in response to decreasing water availability at both diurnal and fortnight time scales. While foliage respiration exhibited enrichment during day (up to 6‰) and a subsequent depletion during night, δ13Cres from roots exhibited an opposite pattern with increasing enrichment at nighttime (up to 5.5‰). This effect became more pronounced with increasing drought. These new findings are in accordance with recent theories regarding post-photosynthetic fractionation in the dark respiratory pathways and during phloem loading, which can have a large effect on δ13CR.

The results obtained by our new model approach and the Intube-incubation technique contribute to a more process-based understanding of isotopic variation in ecosystem respired CO2.

Functional diversity of Central European tree species – Traits, trade-offs and ecological groups

Christoph Leuschner
University of Göttingen, Plant Ecology, Untere Karspüle 2, 37073 Göttingen, Germany

How species influence biogeochemical cycles depends largely on species-specific patterns of resource use, notably the rates of CO2 and H2O exchange, light and nutrient demands, and structural properties of the canopy and root system. Based on a comprehensive data base of literature data of plant ecophysiological and demographic traits and own measurements in various forest ecosystems, I will compare the nine economically most important tree species of Central Europe (birch, pine, Sessile and Pedunculate oak, spruce, fir, hornbeam, linden and beech) with respect to a set of about 20 traits. Most data refer to adult trees with additional information on several attributes of seedlings and saplings. The analysis has three main objectives:

1) to group the species according to functional similarity,
2) to search for trade-offs and correlations among the traits, and
3) to provide a comprehensive parameter set for models of tree and forest ecosystem response to climate change.

The data set is used to challenge the classical dichotomy of tree functional types (pioneer vs. late-successional) by including various ecophysiological and growth-related traits that are rarely considered in descriptions of plant functional types.

Functional role of tree biodiversity in 2 forest ecosystems

Werner C. Kutsch W. et al.

Ecosystems can be characterized in different ways depending on the point of view or the scientific background. Summarizing these views, one can describe ecosystems by their structure and metabolism. The species composition is part of the ecosystem structure. Moreover, ecosystem structures are detailed by biomass or soil and canopy architecture. Ecosystem metabolism represents the functional side. It can be described by primary production, nutrient retention, or control and use of water resources.

Structure and function are connected. The biomass that is produced by the ecosystem metabolism is used to construct the ecosystem structure, which vice versa controls the efficiency of the ecosystem metabolism. One hypothesis is that ecosystems with many species provide a more efficient metabolism than ecosystems with fewer species. We tested this hypothesis by using two ecosystems functional parameters in several deciduous forest ecosystems.

The first example are possible relations between canopy carbon uptake capacity (FP,max) as measured with the eddy covariance technique (ecosystem metabolism) and LAI as well as spatial and temporal variability of leaf traits (ecosystem structure). We investigated leaf traits of four tree species in a mixed deciduous forest in northern Germany in search for an explanation for the differences in canopy photosynthetic capacity between different forest sectors consisting of different species and species numbers (*Quercus robur* + *Fagus sylvatica* , *Fraxinus excelsior* + *Alnus glutinosa*, pure *Fagus*).

We identified leaf traits that were adjusted to the canopy light profile in species-specific ways, and for these traits the plasticity indices were calculated. Canopy photosynthetic capacity did neither correlate with leaf area index (LAI) alone nor with canopy plasticity indices which were almost similar between the three sectors although it differed at the species level. It is suggested that the spatial variability of FP,max in deciduous forests can be explained by a combined effect of LAI and some species-specific reference leaf traits, rather than by the plasticity index or by pure LAI.

In a second study we compared a mixed canopy of *Fagus sylvatica* and *Fraxinus excelsior* to a pure *Fagus* stand during a drought period in summer 2006. Leaf gas exchange measurements suggested that beech trees responded faster and stronger to soil drought and changed stomatal sensitivity to leaf to air water vapour pressure deficit, while *Fraxinus* remained more progressive. Scaling these results in a modelling approach resulted in an lower impact of drought in a two-species canopy than in a beech monoculture and an increase of the *Fraxinus* contribution to total ecosystem carbon uptake.

Both results support the hypothesis that multi-species canopies may buffer unfavourable environmental constraints and increase efficiency in the use of resources.

Simulation of NEE of forests and grassland with a one-dimensional SVAT model on regional scale

Kuhnert, M.; Clausnitzer, F., Köstner, B.
Technical University of Dresden, Department of Meteorology, Piennerstr. 23, 01737 Tharandt, Germany

Climate change will affect the site conditions for plants and will result in shifts of spatial distribution of vegetation. One very sensitive parameter for changes of the site potential is the net primary production (NPP). This can be used to estimate effects of changed climatic conditions on vegetation. To investigate changes at the landscape-level by model approaches spatial differentiation of simulations is necessary.

Within the project LandCaRe 2020 future scenarios of climate are used to simulate the NPP with a one-dimensional soil-vegetation-atmosphere-transfer (SVAT) model. Such models require a high number of parameters which need to be adjusted with respect to the input data based on detailed ecophysiological measurements and physical data for the soil. Simulation results of spatially distributed data have to be validated with observations in the field using data from anchor stations.

In the study differences in the spatial distribution are characterised by soil type and land-use at two test areas in Saxony, Germany. The land-use data based on the CORINE data set and the soil data on the conceptual soil map of the Landesamt für Umwelt und Geologie (LfUG) Saxonia. The considered vegetation types are limited to beech, spruce and grassland. Therefore, the land-use type "conifer forest" is represented by spruce, deciduous forest is represented by beech and all grassland types are combined. For the two test areas Torgau-Oschatz (1200 km2) and Weißeritzkreis (770 km2) polygons with similar combination of land-use and soil type are used as similar functional units. The weather data are used from the weather station at the Anchor Station Tharandt for the Weißeritzkreis and from the weather station of the LfL Sachsen in Köllitsch for Torgau-Oschatz (1997 to 2006). The soil parameters are derived by a pedo-transfer function from the conceptual soil map of the LfUG Sachsen. For the combination of the data set the NPP was simulated with the one-dimensional model SVAT-CN and transferred to each functional unit.

The main objective of the presentation is to estimate the quality of the simulated data and there extension to spatial distributed polygons with available observations in the field. For a spruce stand at the Anchor Station Tharandt data of sap flow measurements (2004 to 2006), net ecosystem exchange (NEE) and evapotranspiration (1996 to 2006) are available including the input parameter for spruce based on measurements at this test site. At a beech stand at Buchhübel (located in the Weißeritzkreis) sap flow measurements (2006) for the validation of the simulated transpiration are available. The data set used for the characterisation of the beech based on measurements at the test site in Hesse, France. The grassland is simulated with vegetation parameters derived from the site Lindenberg (VERTIKO project), Germany, and validated by yield data (1996 to 2006) of the experimental farm Köllitsch (Landesanstalt für Landwirtschaft, Saxonia) as well as by data for NEE and evapotranspiration measured at the test site at Grillenburg (Weißeritzkreis). The comparison of the measurements with simulated data shows reasonable results for the beech and spruce stand as well as for grassland. Shortcomings of validation due to heterogeneous sources of data are discussed.

Large-scale shifts in vegetation and biogeochemical patterns in South Patagonian ombrotrophic bogs

Till Kleinebecker, Norbert Hölzel, Sebastian Schmidt & Andreas Vogel
University of Münster, Institute of Landscape Ecology; Robert-Koch-Str. 26-28, 48149 Münster, Germany

South Patagonian ombrotrophic peatland vegetation is characterized by a distinct shift from hyperoceanic blanket bogs in the west dominated by cushion-building vascular plants to more continental Sphagnum-dominated raised bogs. In past studies, this strong floristic gradient was exclusively attributed to climatic constraints such as the steep decline of annual precipitation from up to 10 000 mm in the western parts to less than 500 mm towards the Patagonian Steppe.

Our findings proved that variation in bog vegetation is well reflected in biogeochemical features of the peat: The availability of base cations and the total nitrogen content decreased with increasing distance to the Pacific Ocean. Differences in base cation availability are most likely attributed to the input of sea-born cations. As a consequence, mineralization and decomposition are presumably enhanced, which result in a better litter quality and higher total N contents of the more oceanic sites with prevailing cushion plant vegetation. Sphagnum magellanicum as the dominating constituent of the eastern bogs was found to be adapted to extremely nutrient-poor conditions reflected by C/N-ratios of up to 250. Total nutrient contents in leaf biomass of selected mire species confirmed the better nitrogen supply by a shift to more phosphorous limited conditions in oceanic peatlands. In general, inter-specific variation concerning biomass nutrient contents was much higher than intra-specific variation along the east-west gradient. In contrast to the former state of knowledge, our findings strongly suggest an important influence of the nutritional status on the floristic composition of South Patagonian peatland vegetation.

A framework to scale-up from species to ecosystem functioning using species traits and abundance

Eric Garnier
CNRS, Centre d'Ecologie Fonctionnelle et Evolutive (UMR 5175), 1919 route de Mende, 34293 Montpellier Cedex 5, France

One pending question in ecology is to understand how species influence ecosystem functioning (EF). It is now admitted that functional diversity, defined as the kind, range and relative abundance of functional traits present in a community, is one of the major factors affecting this functioning [1],[3]. In particular, some specific traits of the dominant species, called effect traits, are thought to strongly influence EF, which is often referred to as the "biomass ratio hypothesis" [5]. In parallel with these questions, the current development of standardized protocols for the measurement of plant traits [2] and data bases centralizing the wealth of information on species traits, e.g. [6] and relevés [7] makes it possible to predict EF on a unprecedented scale, within the range of applicability of the biomass ratio hypothesis. This will be possible if (i) the trait(s) relevant to the ecosystem function of interest is (are) clearly identified, and (ii) the trait value(s) extracted from the data bases can be used in the situations where the relevés are available. This will depend on whether the differences in environmental conditions between the location of the relevé and that where the trait was initially measured are large, and whether the intraspecific variability of the trait is substantial.

Here, I will present a framework that articulates the different steps involved in the approach presented above, and apply it to the case of litter decomposition. Community-level decomposition of leaf litter measured in a Mediterranean old-field succession in Southern France was significantly related to the community weight mean leaf dry matter content (LDMC), calculated from species abundance and LDMC of individual species measured in situ [4]. I will show here community-level decomposition can also be successfully predicted when species LDMC data are taken either from an experiment conducted in an experimental garden or from the LEDA trait base [6], which covers the North-Western part of Europe. These findings validate the general framework proposed in the case of a particular process for which a relevant trait can be identified.

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Grazing intensity changes functional structure and impacts ecosystem processes

Benoit Marion, Nicolas Rossignol, Anne Bonis, Jan Bernard Bouzillé
UMR-CNRS 6553 ECOBIO, Université de Rennes 1, Campus de Beaulieu, 35042 Rennes cedex, France

In grazed grasslands, plant communities structure results notably from the filtering of species regional pool on the basis of traits involved in grazing resistance. Plant height, specific leaf area (SLA), leaf dry matter (LDMC) and leaf nitrogen content (LNC) could constitute important traits to this respect. These traits have also been found to be linked to primary productivity and nutrient cycling. This work intends to simultaneously investigate functional structure (community-aggregated traits and functional diversity) and ecosystem processes for plant assemblages deriving from a panel of grazing intensities.

Two main working hypothesis have been tested: 1- the “Niche complementarity hypothesis” which predicts that communities with high ecological differences among species, i.e. high functional diversity, would optimise resources use and ecosystem processes. 2- the “Biomass-ratio hypothesis” (Grime, 1998) which proposes that species impact ecosystem processes proportionally to their relative biomasses. In this view, aggregated-traits values are expected to relate well with ecosystem processes.

This study was conducted in a in situ experimental design in a wet grassland, controlling for herbivores stocking rates and species (horse or cattle) where a plant patches mosaic was described. Patches contrasted both by their species compositions and their consumption rates by herbivores. Two communities were studied (mesophilous and meso-hygrophilous) for generality purpose. Plant traits (SLA, LDMC, LNC and height) and ecosystem processes (primary productivity and soil nitrogen mineralisation rate) were measured in various grazed patches types and in a long term grazing-exclosure.

Aggregated-traits were found to vary significantly along the grazing gradient. Grazing resistance was associated with both avoidance traits (small height) and tolerance traits (high SLA, high LNC, low LDMC). Functional diversity was lower in the absence of grazing when contrasted functional strategies coexisted in grazed patches. Aggregated SLA and LDMC were respectively corelated positively and negatively with N mineralisation rate and productivity (fig.1) accordingly to the biomass-ratio hypothesis. No clear related pattern emerged between functional diversity and ecosystem processes.

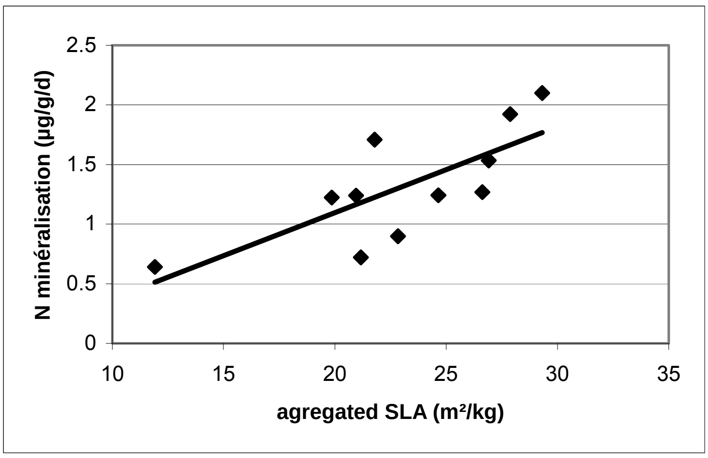

Fig.1 : Relationship between soil N mineralisation rate and agregated SLA (r= 0.75, p<0.05)

Plant functional traits, resource utilization and ecosystem processes in mountain grasslands differing in land use

Michael Bahn, Karin Bianchi, Wolfgang Gamper, Walter Michaeler, Michael Schmitt, Dagmar Rubatscher, Georg Wohlfahrt, Ulrike Tappeiner, Alexander Cernusca
Institute of Ecology, University of Innsbruck, Austria

Land-use changes affect both the composition and the diversity of species in mountain grasslands. The related changes in plant functional traits, rather than species numbers per se, can be considered as major determinants of ecosystem biogeochemical cycles. Nine functional traits of more than 120 vascular plant species in 19 differently managed mountain grasslands across Europe were analysed as regards their response to land use and their within-site variation (i.e. the functional diversity of the ecosystems). It was found that with decreasing intensity of land management specific leaf area and mass-based leaf nitrogen concentrations (NL) decreased, whilst leaf mass ratio and area-based NL increased. The variation of canopy height, a measure of spatial heterogeneity, changed with land use and was closely related to the variation of plant height and carbon/nitrogen ratios, but not of biomass and leaf area. Whole plant resource utilization was generally more strongly affected by plant size and architecture than by physiology. The observed convergence between plant functional traits and ecosystem carbon and nitrogen dynamics indicates a close coupling of processes determining plant and ecosystem functioning across grasslands differing in land use.

Quantifying photosynthetic capacity and its relationship to leaf nitrogen content for global-scale terrestrial biosphere models

Jens Kattge (1), Wolfgang Knorr (2), Thomas Raddatz (3), Christian Wirth (1)
(1) Max-Planck-Institute for Biogeochemistry, Hans-Knöll Str. 10, 07745 Jena, Germany
(2) QUEST University of Bristol, Dept. of Earth Sciences, Wills Memorial Building, Queen's Road, UK
(3) Max Planck Institute for Meteorology, Bundesstraße 53, 20146 Hamburg, Germany

Photosynthetic capacity and its relationship to leaf nitrogen content are two of the most sensitive parameters of terrestrial biosphere models (TBM) whose representation in global scale simulations has been severely hampered by a lack of systematic analyses using a sufficiently broad database. Here, we use data of categorical traits, climate and soil to sub-divide the terrestrial vegetation into functional types (PFT), and then assimilate observations of carboxylation capacity, Vmax (723 data points), and maximum photosynthesis rates, Amax (776 data points), into the C3 photosynthesis model proposed by Farquhar et al. (1980) to constrain the relationship of Vmax25 (Vmax normalized to 25°C) to leaf nitrogen content per unit leaf area for each PFT. In a second step, the resulting functions are used to predict Vmax25 per PFT from easily measurable values of leaf nitrogen content in natural vegetation (1966 data points). Mean values of Vmax25 thus obtained are implemented into a TBM (BETHY within the coupled climate-vegetation model ECHAM5/JSBACH) and modelled gross primary production (GPP) is compared to independent observations on stand scale.

The range of mean Vmax25 between PFTs is dominated by differences of photosynthetic nitrogen use efficiency (NUE, defined as Vmax25 divided by leaf nitrogen content), while within each PFT, the scatter of Vmax25 values is dominated by the high variability of leaf nitrogen content. Apart from providing parameter ranges per PFT constrained from much more comprehensive data, the results of this analysis enable several major improvements on previous parameterisations. 1) We find a systematic depression of NUE on certain tropical soils that are known to be deficient in phosphorous. 2) Vmax25 of tropical trees derived by this study is substantially lower than earlier estimates currently used in TBMs, with an obvious effect on modelled GPP and surface temperature. 3) The root-mean-squared difference between modelled and observed GPP is substantially reduced.

Can plant traits predict soil nutrient cycling?

Orwin, K.H. (1), Buckland, S., Johnson D. , D. (2) Bardgett, R.D. (1)
(1) Soil and Ecosystem Ecology, Lancaster University, Lancaster, LA1 4YQ, UK
(2) Institute of Biological and Environmental Sciences, Cruickshank Building, University of Aberdeen, Aberdeen, AB24 3UU, UK

Although it is recognised that different plant species result in different soil systems, we do not yet fully understand which plant traits are the primary drivers of those effects. Such understanding is required to predict how ecosystems will respond to species invasions, and how changes in species composition may affect ecosystem services. It has been proposed that plants that have a slow growth rate will produce lower quality litter that slows down rates of decomposition and leads to shifts in soil microbial community composition towards fungal-dominance. In contrast, plants that have a fast growth rate should produce high quality litter that results in faster rates of decomposition and a bacterial-dominated soil microbial community. However, to date this has not been experimentally tested.

We tested these hypotheses using 7-year old monoculture plots in an upland temperate grassland in Scotland. These plots consist of monocultures of 9 grassland plants of contrasting functional type that vary in their relative growth rates, an unplanted control, and a natural grassland community. Soil microbial activity (basal respiration), biomass (FE), and a number of soil chemical variables were measured on soil collected from each plot. Relationships between plant traits and soil properties were determined using regression analyses.

Results showed strong effects of plant species composition on soil properties. However, contrary to our prediction, relative growth rate was unable to predict any of the soil variables. Stepwise regression analyses using leaf traits (specific leaf area, leaf dry matter content, leaf toughness, leaf thickness, leaf %N) and root traits (root density, root %C, root %N, root %P) as independent variables indicated that leaf %N was the best predictor of soil ammonium concentrations (r^2 = 0.78), that root density was the best predictor of in situ CO_2 fluxes, total inorganic N and mineralisable N ($r^2 > 0.5$) and that root C was the best predictor of soil nitrate concentrations (r^2 = 0.7). However, neither leaf traits nor root traits showed any significant relationships to basal respiration, microbial biomass, or decomposition rates.

Overall, our results suggest that soil nitrogen pools may be predictable based on plant traits. However, plant traits, in this study system at least, were unable to predict soil properties more closely linked to the carbon cycle (e.g. basal respiration decomposition rates). This suggests that links between plant species and the soil system are not as straight forward as we might predict.

Poster presentations

Agrochemicals Risk Assessment for Pollinators

*Stefania Barmaz *, Alessio Ippolito & Marco Vighi*
University of Milano-Bicocca, Department of environmental landscapes sciences; Pizza della Scienza 1, 20126 Milano, Italy

Pollinators are well known to provide key ecosystems services to both natural and agro-ecosystems [1]. Anyway in agroecosystems this service may be at risk because of use of agrochemicals. Within ALARM project, a specific activity (PACRAT: Pollinators and pollination in response to Agro-Chemicals and land-use as a Risk Assessment Tool) was planned in order to develop, apply and validate a methodology to assess risk for pollinating insects in agroecosystems. The procedure was applied to 23 "4x4 kilometres" field sites distributed all around Europe (figure 1) and representatives of the most important crops (cereals, olive, vineyard and orchard) and climatic conditions. For each field site a "disturbed" and an "undisturbed" 4x4 km square was selected. In each site data on pesticide application were collected to predict pollinator exposure in space and time. In the meantime environmental samples (foliage, pollen, flowers) had been collected to validate exposure prediction. Three sampling dates were decided as a function of the main insecticides applications:

1st sample: before pesticide application on main crops (e.g. for most cereals in south-central Europe, end of March-early April, for other crops even later);

2nd sample: within two weeks after the first relevant pesticide application period (e.g. for cereals in south-central Europe, middle April);

3rd sample: within two weeks after the second relevant pesticide application period (if one), in any case not less than one month after 2nd sample.

For each site a map of theoretical risk from agrochemicals was developed taking into account land use, environmental fate of active ingredients and feeding behaviour of most important taxa of pollinators. Oral and contact exposure were taken into account as the main exposure route for pollinators an related maps were developed.

Figure 1: Selected field sites for PAC

After a preliminary worst case risk assessment, insecticides had been selected to develop risk maps. For each of the main taxa, exposure was evaluated taking into account data on pollen collection and feeding area of pollinators. Starting from landuse and agrochemical data a TDI (Total Daily Intake) was calculated and compared to short term and acute ecoxicological endpoints to characterize risk for pollinators.

The obtained maps were compared with data on biodiversity of pollinators communities, collected for each site within ALARM project, to calibrate and validate the proposed risk assessment procedure.

Despite of the availability of official risk assessment procedures, e.g. European and Mediterranean Plant Protection Organisation (EPPO) guidelines No.170 [2] and related scheme for honeybees [3], few are the studies that underline actual effect of agrochemicals on natural communities. Furthermore traditional ...**abstract to long/cut**

Spatial and temporal differentiation of net primary production and organic matter decomposition in agricultural landscape of Wielkopolska – West Poland in global change context.

Zdzislaw Bernacki
Research Center for Agricultural and Forest Environment PAS, Bukowska Street 19, 60-809 Poznań, Poland

Net primary production (NPP) and organic matter decomposition rate of different ecosystems (agricultural fields, meadows, afforestations and forests) in agricultural landscape were studied. Influence of climatic and soil factors on these processes was determined. Impact of landscape structure, especially midfield shelterbelt effect, on NPP and decomposition rate was also estimated.

Average NPP values in particular ecosystems were 1804,08 g d.w$\cdot$m^{-2} in agricultural fields, 2047,57 g d.w$\cdot$m^{-2} in meadows 1666.99 g d.w$\cdot$m^{-2} in afforestations and 1374.37 g d.w$\cdot$m^{-2} in forests. Differences of NPP between distinguished types of ecosystems were insignificant. Statistically significant differences were found between seasons.

The main factors influenced NPP were: a) soil humidity, b) sum of rainfall in vegetative season, c) mean air temperature in vegetative season. There wasn't any dependence of NPP on nitrogen and phosphorus content in soil

Decomposition rate was more differentiated then NPP and influenced by more factors. The highest rate of decomposition was found on a meadows, the lowest in forests. Range of decomposition rate coefficient was between 0.2 mg$\cdot$g$^{-1}\cdot$d^{-1} in forest, in winter and 16.0 mg$\cdot$g$^{-1}\cdot$d^{-1} on the meadow, in summer. The main factors influenced decomposition rate were: a) sum of rainfall during study period, b) sum of rainfall during last two years, c) sum of temperature over 5^0C, d) N:P ratio in decomposed material, e) N and P content in the soil.

Impact of landscape structure on studied processes was clearly visible on agricultural fields. Presence of midfield shelterbelts influenced primary production mainly by modifying of soil humidity, while decomposition rate was modified mainly by changes in soil fertility, caused by different intensity of soil erosion near shelterbelts.

Gained results showed, that climate change prognosed for Polish Lowland i.e.: increase of temperature and shift of rainfall to winter period will elevate impact of environmental factor on NPP and decomposition rate. Water availability should become more serious problem for maintenance of NPP, especially on crop fields. Changes in NPP, may change content of chemical elements in plant biomass. In consequence decrease of humidity and reduction of N content in litter should also diminish decomposition rate and retard biogeochemical cycles.

Resource availability effects translocation and accumulation of nonessential heavy metals (and radionuclides) more than drought in trees

Carsten Brackhage, Gert E. Dudel
Institute of General Ecology and Environmental Protection, TU Dresden, Germany

Nonessential elements, depending on their bioavailability, are not transferred in relevant amounts into aboveground plant parts by most plant species and especially woody plants (avoidance, Baker et al. 1994) with the exception of some hyper-accumulator plants. In general nonessential elements do not play a major part in neither internal biochemical cycling nor biogeochemical cycling compared to essential elements like potassium or calcium. Most of these elements accumulate in or on roots, in root litter and humic substances unless they are discharged bound e.g. to DOC. On the other hand some plants take up and accumulate nonessential elements to a larger extent in aboveground plant parts hence include them into internal and biogeochemical cycling. Experimental data as well as investigations on site show that in most cases these plants are not able to maintain the inner homeostasis to avoid the stress. This leads to low productivity and the accumulation of e.g. heavy metals which in turn destabilises the system further. Consequently, ecosystem functions as well as biogeochemical cycling are affected.

Based on investigations on contaminated mining dumps the uptake, accumulation, and translocation of essential and nonessential elements by woody plants were investigated under controlled conditions (pot experiments, open-top chambers) with increasing limitation of water (drought) and selected nutrients. Results here focus on the nonessential element uranium. As mentioned for other nonessential elements uranium accumulates in the roots and here mainly in the root cortex of different species. Overall transfer to the shoot is very low. Leaves do have higher uranium concentrations than stem and twigs depending on the conditions the plants were grown in. The pattern of internal cycling can be compared to that of calcium. An effect of low water availability (drought) is not very obvious. The effect of low phosphor availability in the soil on uranium uptake and translocation is predominant. This is discussed in the context of:

- chemical speciation and complexation of metals (uranium) by organic polymers (e.g. carbonic acids, aromates) on root surfaces together with cation – anion exchange mechanisms.
- drought affecting bioavailability of uranium and transpiration hence uptake intensity
- phosphorus deficiency which enhances uranium uptake due to stoichiometric imbalances.

It is concluded that a general validity has to be proofed using more and different species as well as trees of different age. Moreover the effect of energy deficiency (PAR-Limitation) on the homeostasis and stress compensation might be of major interest together with investigations on the possibly synergistic effects of other stress factors (e.g. ozone, NO_x, herbicides).

Putting demography into its ecological context

Johan P Dahlgren & Johan Ehrlén
Stockholm University SE-106 91 Stockholm, Sweden

The connection between demography and the abiotic environment is a "missing link" in ecology. Effects of biotic interactions on vital rates are better known but have only rarely been linked to population dynamics. The ultimate effects of environmental factors on population dynamics are evident from studies linking differences in environment to species distributions, densities, and population sizes. Demographic studies have also shown differences among patches of plants. However, explicitly linking abiotic and biotic environmental factors to demography is necessary to fully understand and predict population dynamics.

Advances in computer technology and modeling tools now enable simultaneous analyses of the importance of multiple environmental factors by their inclusion in demographic models. We have studied the importance of abiotic and biotic interactions to population growth rate of *Actaea spicata*. *A. spicata* is a long lived perennial herb occurring in nutrient-rich forests. We conducted a detailed demographic study over three years on a total of 1 323 individuals, and assigned environmental variables to each individual. Using linear and logistic regression analyses, we selected the most important out of eleven environmental variables affecting individual growth, survival and reproduction by choosing the best sub-models based on Akaike's Information Criterion (AIC). Soil potassium concentration, acting on individual growth, and pre-dispersal seed predation by a specialist Geometrid moth appeared to be the most important environmental factors. We therefore incorporated these two factors into integral projection models of population dynamics. At the population level, both factors were found to potentially limit the habitat range of this species due to their effects on population growth rate (Fig. 1). The change of potassium concentration over forest succession can also be incorporated into the models which can then show the effect of temporal environmental change.

Demographic approaches such as this one, that have simultaneously assessed abiotic and biotic effects on population growth rate, should be important tools to establish the links between environment and dynamics of populations and communities. This approach would also be useful to adopt in Population Viability Analyses. The most useful application may be to incorporate deterministically changing environmental factors in future demographic models. Particularly, due to the increased attention of effects of climate change, but also because of processes such as eutrophication and succession.

Abstract too long for print

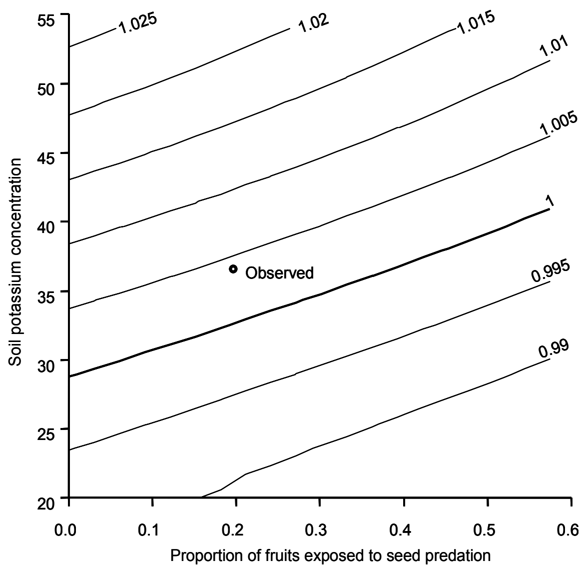

Figure 1. Population growth rate (λ) as a function of different levels of soil potassium concentration (mg per 100 g soil) and seed predation (proportion of damaged fruits).

Effects of extreme climate events on temperate plant communities

Freja Dreesen & Hans J. De Boeck
Research group of Plant and Vegetation Ecology, University of Antwerp, Universiteitsplein 1, B-2610 Wilrijk, Belgium

Climatic changes have received a lot of scientific attention the past decade, but the majority of these studies only focus on mean climatic changes, although the impacts of extreme climatic events such as heat waves and drought periods on plants are thought be potentially greater. Moreover, the predicted fast increase in frequency of occurrence of such extreme events further stresses the importance of research on this topic. Periods of heat and drought can affect plant functioning in a variety of negative ways (e.g. damage to membranes, reduced photosynthetic electron transport, altered growth and carbon allocation), but heat waves could also stimulate plant growth in certain seasons if their occurrence brings temperatures closer to the metabolic optimum, as could be the case in spring or autumn. Nevertheless, very little research exists on such seasonal responses. Furthermore, the interactive effects of heat and drought waves, which can be more detrimental than either stress alone, are still poorly understood.

We therefore exposed identical three-species plant communities to extreme heat and/or drought waves induced in three different periods of the year (late spring, summer or early autumn). Heat waves were created using the FATI technique (Free Air Temperature Increase), through which vegetation is heated in a uniform and precise manner, using infrared heating lamps. Our plant communities were watercontrolled and drought was created by withholding water from the plants. The intensity of the 10-day heat waves and the duration of the drought period were computed from the database of the Royal Meteorological Institute of Belgium to simulate extremes that currently occur on average once every 75 years.

Here we present preliminary data of 1) the influence of the separate and combined effects of heat waves and drought periods and 2) the seasonal effects of these extreme events, through the measurement of ecophysiological parameters such as photosynthesis, transpiration, water-use-efficiency, chlorophyll fluorescence, etc.

Are plant tissue nutrient concentrations an appropriate indicator for the nutrient supply status?

Ronny Goldberg & Michael Manthey
Ernst-Moritz-Arndt-University, Institute of Botany and Landscape Ecology;
Grimmer Str. 88, 17487 Greifswald, Germany
ronny.goldberg@uni-greifswald.de

Nitrogen and phosphorus tissue concentrations in plants as well as the N:P ratio are increasingly used as indicators for nutrient limitation. There is an ongoing debate whether nutrient concentrations are a plant trait or dependent on available nutrients. For the latter an increased uptake in case of bigger supply would be expected.

So far research on this topic has focussed on wetland ecosystems. In our study we sampled total standing crop biomass for functional groups (grasses, herbs, legumes) as well as five widely distributed species (*Achillea millefolium, Arrhenatherum elatius, Elytrigia repens, Holcus lanatus, Plantago lanceolata*) on grassland sites in Northeastern Germany that are not effected by ground water but reflect a gradient in nutrient supply. Additionally, we used data from a fertilizing experiment. Vegetation composition was recorded and biomass samples analysed for P and N content. Ellenberg indicator values and total standing crop biomass were used as a first estimate for nutrient status.

Species differed in their performance concerning tissue nutrient content for empirical and experimental data.

For experimental data there was no consistent pattern for P concentrations. By contrast N concentrations where higher for all species in all fertilized plots. Here *Holcus lanatus* showed the weakest dependence on increased nutrient supply. Species N concentrations varied more among treatments than among species.

On field sites all species varied in responses. Nitrogen concentrations in *Plantago lanceolata* and *Holcus lanatus* were significantly correlated to mean Ellenberg nitrogen values and total standing crop biomass. For all other species and for phosphorus concentrations no correlation could be investigated.

Nitrogen content in plant tissue responded to increased nutrient availability but differed significantly between the investigated species. At least nitrogen concentrations are both site dependent and a plant trait.

Effects of the extreme drought in spring 2007 on productivity and biomass nutrient content in alluvial meadows

Norbert Hölzel, Valentin Klaus, Jörg Sintermann,
University of Münster, Institute of Landscape Ecology, Robert-Koch-Str. 26-28, 48149 Münster, Germany

In most parts of Central Europe, spring 2007 was characterized by extremely dry and unusually warm weather conditions with zero precipitation and daily maximum temperatures mostly above 25 °C for more than seven weeks between March 25 and May 6. This situation bears a close resemblance to what many regional climate models predict for the late part of the 21st century. In this paper, data demonstrating the impact of the extreme spring drought in 2007 on productivity and leaf nutrient concentration of alluvial grasslands in the Upper Rhine valley are presented. Although species composition and soil nutrient content suggested a steep trophical gradient under average conditions, the extreme spring drought led to an unexpected equalisation in the amount of standing crop and nutrient concentrations in aboveground biomass of alluvial meadows. Biomass production and nutrient contents in highly fertile species-poor meadows dropped to the level of mesotrophic species-rich stands containing numerous rare and endangered species. Our finds suggest a future shift in Central European grassland vegetation towards drought-tolerant species with low nutrient demands irrespective of soil nutrient potentials. Implications for biodiversity, nature conservation and management will be discussed.

Effects of elevated CO2 on the growth of seedling Pinus densiflora and soil enzyme activities

Sung Hyun Kim (1), Soo Hyun Chung (2), Ho Jung Kang (3), In Sook Lee (1)
(1) Department of Eco Science, Ewha Womans University, 120-750, Seoul, Korea
(2) Department of Environmental Science and Engineering, Ewha Womans University, 120-750, Seoul, Korea
(3) Department of Civil and Environmental Engineering, Yonsei University, 120-749, Seoul, Korea

Elevated atmospheric CO2 concentration influence function of plant phytosynthesis, and there caused the change on soil material cycle. This work was investigated the effects of the concentration of elevated CO2 on the growth of Pinus densiflora and soil organic matter digestion ratio of microbe. Three-year pine trees were planted and cultivated for 12 months in the growth chamber where CO2 concentration was controlled at 380 and 760 ppmv respectively and we measured by 4 months. Soil physical-chemical parameters in both bulk and rhizosphere soil were not affected by the CO2 concentration increased during whole experimental periods. The root elongation and biomass of pine was not affected by the CO2 concentration increased, but C: N ratios of pine leaf were increased under elevated CO2. Dehydrogenase activities of soils were not affected, but activites of β-glucosidase, N-acetylglucosaminidase and phosphatase were influenced by elevated CO2. Especially, these activities in bulk soil significant were increased by elevated CO2 ($p<0.05$). Thus, elevated CO2 concentration can affect chemical metabolism on pine tissue and path of organic decomposition although it has not an effect growth of pine and soil enzyme activities.

Table 1: C:N ratio of *Pinus densiflora* grown under ambient or elevated atmospheric CO_2

Organ		**4M**	**8M**	**12M**	
needle	C	38.7	37.9	33.9	←
	E	44.1	50.5	51.2	→
Root	C	39.7	40.0	39.2	=
	E	39.8	39	39.6	=

FIGURE FORMAT!

Abstract too long/cut!

Short term effect of eutrophication on carbon cycling in grassland ecosystem

Eva Kaštovská, Tomáš Picek., Kateřina Zemanová, Keith R. Edwards
Department of Ecosystem Biology, Faculty of Sciences, University of South Bohemia, Branišovská 31, CZ-37005 České Budějovice, Czech Republic

Two grasslands in Czech Republic were studied: (1) a nutrient poor sedge meadow on organic soil and (2) a mesotrophic sedge-sweet grass meadow on mineral soil. Eutrophication was simulated by the application of NPK fertilizer to selected permanent plots in 2006 and 2007 in amounts of 9 kg N + 4 kg P ha^{-1} $year^{-1}$ (low dose) and 45 kg N + 20 kg P ha^{-1} $year^{-1}$ (high dose).

After two years of fertilizer application, we observed an increase in net aboveground plant production (about 9-12 kg ha^{-2} $year^{-1}$) connected with an increase in shoot:root ratio in fertilized plots of both sites, with more pronounced changes in oligotrophic sedge meadow. Although these changes were not statistically significant, they were reflected by a markedly higher in situ total CO_2 efflux from the ecosystem as well as by significant increase in total soil respiration in case of sedge meadow. At mesotrophic site, we found no significant effect of fertilization on CO_2 efflux from the system. Effect of fertilization on methane and nitrous oxide emissions from both meadows was also studied, however, the emissions were negligible (under detection limit) from all plots at both sites during the whole study period. Fertilization also caused changes in soil microbial characteristics. After nutrient addition, we observed a decrease in C:N ratio of microbial biomass, increased amount of soluble recalcitrant carbon in soil and some hints of enhanced soil nitrogen cycle. Due to the non-significant direct effect of fertilization on microbial N transformation, we suppose prevailing immobilization of added nutrients by plants and important role of indirect effects on soil microbes mediated by plants in longer-term.

Above mentioned plant and soil responses to fertilization indicate on-going changes in C flux and its allocation within the system as higher plant photosynthetic and respiration activity, higher carbon losses from rhizosphere, changes in composition and activity of soil microbial community and shift in biochemical composition of soil organic matter in fertilized plots. Peaty oligotrophic soil seems to be more sensitive to nutrient addition then mineral soil. However, final effect of fertilization on ecosystem C balance stays unknown and longer study is necessary to draw explicit conclusion.

Effects of elevated atmospheric CO2 concentrations on pests of oilseed rape

V. Kryvynets, P. Högy, J. Franzaring, A. Fangmeier
Institute for Landscape and Plant Ecology, Universität Hohenheim, 70593 Stuttgart

One of the reasons for global climate change is the increase in the atmospheric CO2 concentration [2], which will influence plant growth, the habitat and nutritional conditions of phytophagic insects due to alterations in the chemical composition of plant tissues [1], [4]. As proposed by [3], changes particularly in the carbon to nitrogen ratios within plant tissues may lead to larger damage by insect consumption due to greater population growth.

In 2007, oilseed rape (Brassica napus L. ssp. napus) was cultivated at the Universität Hohenheim (Germany) in an open field experiment using a Mini-FACE (free-air carbon dioxide enrichment) system in order to examine potential effects of CO2 enrichment on pests. Exposure consisted of three CO2 treatments utilising five replicates each: Control – ambient CO2 without technical equipment (380 µl l-1 CO2), Ambient – ambient CO2 with technical equipment (380 µl l-1 CO2) and FACE – elevated CO2 with technical equipment (530 µl l-1 CO2). The progress of pest infestation was monitored from leaf emergence until crop maturity using two methods: (i) pest counting per plant and (ii) applying yellow adhesive traps to collect representative samples over weekly intervals. Occurrence of Athalia rosae L., Cicadella viridis L., Dasyneura brasicae L., Delia radicum L., Frankliniella occidentalis L., Meligethes aeneus L. and Trialeurodes vaporariorum L. was observed upon the plants. Significant CO2 effects were observed only during flowering of oilseed rape (84 days after sowing) on Meligethes aeneus L. using method (i) and at ripening (91 days after sowing) on Cicadella viridis L. using method (ii). Average numbers of Cicadella viridis L. reached 0.4 ± 0.89 individuals per trap under 380 µl l-1 CO2 and 2.0 ± 1.22 individuals per trap at 530 µl l-1 CO2. For Meligethes aeneus L. 0.6 ± 0.14 individuals per plant were found under 380 µl l-1 CO2 and 0.34 ± 0.08 individuals per plant at 530 µl l-1 CO2.

Phenology was accelerated under elevated CO2. Results suggest that the occurrence of Cicadella viridis L under elevated CO2 is more than under normal atmospheric CO2. It is recommended to follow up experiments as elevated CO2 concentrations affect the phenology of the crop and may increase the risk of pest outbreaks in crops in the future at specific growth stages.

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10 years of Free Air Carbon dioxide Enrichment (FACE) on grassland: Are there long-term effects on soil C pools and the ecosystem trace gas balance?

Lenhart K., Kammann C., Grünhage, L., Jäger H.-J.
Justus-Liebig-University, Department of Plant Ecology, Heinrich-Buff Ring26-32, 35392 Gießen, Germany

Increasing the soil C stocks is of major interest to mitigate the rise in atmospheric CO2-concentration and therefore global warming, although evidence for a CO2-induced increase in soil C pools is limited and the results are rather inconsistent ([1], [2],[3]). However, as step-increase effects at the beginning of a CO2-enrichment experiment may alter the ecosystem responses to elevated CO2, long term studies are needed to make reliable predictions. In this study we examined the effects of elevated CO2 on C sequestration and the greenhouse gas (GHG) balance of CO2, N2O and CH4 over a period of 10 years.

The Gießen-FACE experiment started in May 1998 with a year-round CO2-enrichment of +20 % above ambient, i.e. 440 ppm. The δ13C signature difference applied with the enrichment-CO2 was used to calculate the C-input under elevated CO2. Trace gas measurements started in 1997 via closed-chamber technique with two measurements per week since that time.

Between 1998 and 2006 the soil C input corresponded to 93.5 g C m-2 yr-1 in the soil profile (45 cm). However, no CO2-induced net increase in the soil C pools occurred in any depth. Over the whole period, elevated CO2 increased N2O emissions about x % compared to ambient, CH4 oxidation was reduced by x %. Theoretically, simply to offset the additional N2O emissions (i.e. x g m-2 yr-1), x kg C m-2 yr-1 must be additionally sequestered every year. Besides the absence of an increase in the soil C pool under elevated CO2 in this study, there is evidence that the amount of C that can be stored in the soil is limited [4].

Therefore, the capability of (grassland) ecosystems to reduced GHG and thereby counteract global warming may be limited. Likely, some ecosystems that are predicted to act as a net CO2-sink in the future will become a net GHG source when taking into account the CO2-induced changes in the fluxes of N2O and CH4.

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Effects of atmospheric CO2 enrichment on growth parameters and energy content of oilseed rape

D. Lünsmann (1), P. Högy, J. Franzaring, A. Fangmeier
(1) Institute for Landscape- and Plant Ecology, Universität Hohenheim, 70593 Stuttgart
Dagmar.Luensmann@uni-hohenheim.de

The atmospheric carbon dioxide (CO_2) concentration has increased globally by about 100 ppm (36%) over the last 250 years, from approx. 280 ppm in the pre-industrial era to 379 ppm in 2005. The increase has now reached the highest values ever. From 1995 to 2005 a CO_2 increase of 19 ppm was recorded and for the end of this century a total of about 550 ppm atmospheric CO_2 is predicted [1]. This rise of the atmospheric CO_2 concentration is obviously caused by anthropogenic emissions of CO_2, mainly emissions due to fossil fuel combustion.

As CO_2 is the major greenhouse gas and thus, a major cause of the global climate change, the mitigation of CO_2 emissions is highly important. One way amongst others is the use of energy crops in order to substitute fossil fuel.

Oilseed rape (*Brassica napus* L.) can be used as such a renewable energy source. Therefore a summer oilseed rape, cv. Campino, was chosen for an experiment with a free-air carbon dioxide enrichment (FACE) system at a research station of the University of Hohenheim. The Hohenheim Mini-FACE system consists of 15 field plots of 2 m in diameter. Five plots each were exposed to one of the three different treatments: (i) elevated CO_2 treatment [+150 ppm] together with the technical equipment needed (FACE); (ii) ambient air together with the same technical equipment, but no additional CO_2 (Ambient); (iii) ambient air and no equipment (Control) [2].

Numerous studies have shown that atmospheric CO_2 enrichment has positive effects on photosynthetic activity and it leads to more „efficient“ plants [3]. They show an increase in biomass production and yield and an enhanced water- and N-use efficiency [4, 5]. In the present experiment, the phenology of oilseed rape plants was recorded according to the BBCH-Code during the whole vegetation period [6]. The chlorophyll contents of selected leaves were measured weekly with the Minolta SPAD-502 leaf chlorophyll meter and the leaf area of the canopy was measured by using a LAI-2000 plant canopy analyzer. In addition, the energy content of biomass fractions (stems/leaves and seeds) was determined at maturity.

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FET - a trait database for earth system science and functional biodiversity research

Steffi Nöllert, Jens Kattge, Gerhard Böhnisch, Angela Nüske, Sabine Reinsch, Rongjun, Ni Jian, Christian Wirth
Author informations missing

The inter- and intra-specific variation and co-variation of plant traits is the raw material of functional biodiversity research serves as the basis of any data-oriented definition of plant functional types and provides essential information for the parameterization of terrestrial biosphere models. The Functional Ecology of Trees database (FET) was specifically designed to assimilate literature data at regional and global scales for a great variety of traits related to tree physiology, structure and demography and ecosystem traits and to combine these with substantial information on environmental covariates. Literature studies do generally not follow common protocols, i.e. they apply various methods and treatments, use different functional forms to estimate traits etc. The FET database has realized a high degree of flexibility to accommodate to such heterogeneous data. Literature studies rarely provide an ample set of required environmental covariates. To achieve comparability and to fill these gaps of covariates the FET database has inbuilt functionalities to query regional and global datasets on soil, geology, topography and climate. Currently, two groups (the group at MPI-BGC and a US-team lead by Prof. Kiona Ogle, Wyoming State University) are compiling information on American, European and Asian tree species using the FET database. We will introduce the key features of our database design, will provide an overview of the current state of data entry and will give brief examples of recent applications ranging from trait analyses to parameterization of earth system models

Selective logging in lowland rainforests in southern Chile: Effects on species composition and nitrogen transformations

Cecilia A. Pérez (1), Martín R. Carmona (2), José M. Fariña (1) and Juan J. Armesto (1,2)
(1) Center for Advanced Studies in Ecology & Biodiversity (CASEB), Departamento de Ecología, Pontificia Universidad Católica de Chile. Alameda 340. Santiago, Chile
(2) Instituto de Ecología y Biodiversidad (IEB), Departamento de Ciencias Ecológicas, Facultad de Ciencias, Universidad de Chile, Casilla 653, Santiago, Chile

Lowland evergreen rainforests in southern Chile are intensively logged because they grow on highly productive soils and they are easier to access than montane forests. Old growth southern temperate forests have being defined has highly conservative, nitrogen use efficient and nitrogen limited. Silvicultural practices that change forest structure and composition can alter key ecosystems functions that are highly dependent on the quality and quantity of organic matter that enters the ecosystem, such as microbial nitrogen transformations. To test this hypothesis we selected lowland evergreen rainforests in Chiloé Island in southern Chile, that were affected by conventional selective logging 10 years ago (CSL) for industrial fabrication of plywood, non-conventional selective logging (NCSL) meaning the use of forest from small landowners for firewood, and reference uncut old growth forests (unlogged OG). The decrease in basal area was higher in the stands with CSL than in NCSL, however litterfall input was similar in the three treatments, because of the abundance of understory species with canopy opening. In NCSL dominant understory species have a significantly higher C/N ratio of litterfall than in CSL. Unlogged OG forests have significantly higher rates of non-symbiotic nitrogen fixation in the Ol horizon (estimated by the acetylene reduction assay) and higher net N mineralization in surface soils than logged forests. There was a trend of a higher denitrification rates (estimated by the acetylene inhibition assay) in soils and a higher NO3-N/Nt in the streams of CSL, which enriched δ15N signal in surface soils. There was a significant positive correlation of non-symbiotic nitrogen fixation and net N mineralization and nitrification. A significant negative correlation was found in C/N ratio of litterfall and denitrification rates in soil. We conclude that the dominance of the intolerant understory bamboo species Chusquea quila in CSL, with a lower C/N ratio of litterfall, loose the tightness of the nitrogen cycle by increasing nitrogen availability and therefore the potential of nitrogen losses, either hydrological or gaseous. On the contrary in NCSL a higher C/N ratio in litterfall would decrease the chances of N losses increasing C and N storage in soil. In unlogged OG, even though C/N ratio of litterfall is similar to CSL and net N mineralization is higher than NCSL, available N is lower in soil, probable because a higher evapotranspiration by tree canopy. This will decrease the chances of N losses in unlogged OG forest.

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Influence of thinning and type of canopy on soil physicochemical characteristics in a mixed forest from the western Pyrenees

I. Primicia, I. Arzoz, F. J. Arricibita, J. B. Imbert, M. Unzu, S. García and F. J. Castillo
Universidad Pública de Navarra, Arrosadía S/N, 31006 Pamplona, Spain

Effects of thinning and type of canopy on soil physicochemical characteristics are being studied in Aspurz, a mixed forest in the Western Pyrenees (northern Spain). There are three types of plots (30 x 40 m) set up in 1999, with three replicates of each: P0 (not thinned), P20 (reduction of 20 % in basal area) and P30 (reduction of 30 %). Within each plot Pinus sylvestris and mixed patches (P. sylvestris and Fagus sylvatica) are distinguished. PVC cores were used to take soil samples and estimate net N mineralization (n = 6 per treatment) in the field. Microbial N was determined using CFE procedure. Unlike in 2002 and 2003, in 2007 significant reductions for Ca (12%), Mg (17%), conductivity (15%) and microbial N (11%, only analyzed in 2007) have been detected in horizon A of P20 and/or P30 relative to that of P0. This nutrient decrease appears to be due to the reduction in litterfall caused by thinning. No differences in NH4+ and NO3- production were detected between pine and mixed patches. However, NH4+ amounts were significantly lower in mixed patches than in pine patches probably reflecting higher nutrient absorption rates by F. sylvatica. It appears that thinning has caused a lagged alteration of nutrient stocks in soil by reducing nutrient inputs via litterfall. Results also suggest a possible belowground competition for NH4+ between P. sylvestris and F. sylvatica.

Belowground zone of influence in a tussock grass species

Francisco I. Pugnaire & Cristina Armas
Estación Experimental de Zonas Áridas, CSIC, General Segura 1, 04001 Almería, Spain

Plant competition belowground is strong and mediated trough resource depletion and an enormous variety of exudates intended to regulate soil microbial communities in the rizhosphere, cope with herbivores, encourage beneficial symbioses, and change chemical and physical properties of soil. However, these secondary compounds contribute to active root segregation and affect neighbours' growth.

We investigated with field and greenhouse experiments the belowground zone of influence of Stipa tenacissima, a tussock grass species dominant in semiarid SE Spain which under some circumstances shows a fringe devoid of vegetation around the tussock.

Fringe size was a function of water availability, so that the more water available the smaller the fringe and vice-versa. Above-ground plant mass was higher in gaps than in the fringe, but root mass was higher in the fringe. More species emerged in soils from gaps than in soils from the fringe, and productivity was ten times higher in soils from gaps than in soils from the fringe. Growth of barley plants was inhibited close to S. tenacissima tussocks in field and greenhouse experiments.

Stipa tenacissima produced a belowground zone of influence around the tussock through resource depletion, particularly water, and allelopathy where other species seldom appear. This area has important effects for plant establishment, influencing population and community dynamics in these semiarid environments.

Foliar nutrient concentrations of South Patagonian bog species along a climatic and floristic gradient

Sebastian Schmidt, Andreas Vogel, Norbert Hölzel, Till Kleinebecker
Institute of Landscape Ecology, University of Münster, Robert-Koch-Straße 26, 48149 Münster, Germany

We examined the variation of foliar nutrient contents (N, P, K, Ca, Mg and Na) of South Patagonian ombrotrophic peatland species and how these species respond to a changing nutrient availability along a gradient of increasing continentality. Particular attention is set on nutrient demands of Sphagnum magellanicum as the dominant constituent of continental raised bogs and on those of cushion-forming vascular plants dominating in hyperoceanic blanket bogs. First, we hypothesized that all species are generally characterized by extreme low foliar nutrient concentrations due to the ombrotrophic conditions and the low atmospheric nutrient supply. Second, we expected increasing nutrient concentrations towards the west due to the increasing input of sea-born cations as well as a higher nutrient availability in the peat.

Nutrient concentrations were generally lowest in Sphagnum and highest in the considered graminoid species. Nutrient contents in cushion plants differed widely. Donatia fascicularis had relatively low nutrient concentrations, whereas nutrients in Astelia pumila tended to relatively high concentrations.

Although variation in foliar nutrient concentrations was mainly reflected by the interspecific variability, a moderate shift along the considered gradient was distinguishable. N- and Ca-concentration increased and P-concentrations decreased westwards in most species. Consequently, the most noticeable shift was an increasing N:P ratio that suggests an increasing P-limitation from east to west. Our results clearly suggest that variation in the floristic composition of South Patagonian bog ecosystems is not exclusively caused by the steep climatic gradient as assumed in the past, but to an important part by a trophic gradient.

Impact of past land use on forest soils in the Hainich-Dün Region, Central Germany

Jana Wäldchen & Prof. Dr. E.D. Schulze
Max Planck Institut für Biogeochemie, Hans-Knöll-Str. 10, 07745 Jena

Based on the increasing understanding of the role of land-use history in present biogeochemical cycles the present study deals with the question, how much current carbon pools on forest sites are influenced not only by the present ecological conditions and land-use, but also by anthropogenic interventions in the past. Management practice like clearing and agricultural use of forest surfaces, coppice, coppice with standards and high forest management as well as forest pasture, litter raking and other management options may still have an effect on the current state of forest soils and forest structures. Former and temporary conversion of forests into agriculture with associated ploughing, fertilization and irrigation led directly to changes of soils that last a very long time.

The overall objective of this study is to reconstruct the history of forest management in forest ecosystems in the northern part of Thuringia and to investigate the impact of former land-use on carbon pools. On the basis of comparative investigations on several homogeneous study plots it is examined how anthropogenic interventions have changed the soil structure and the nutrient relations. The following questions are investigated:

How has the change of the forest ecosystems, affected by anthropogenic use in the past, impacts on morphological, physical and chemical qualities of the soils?

Which meaning do historical interventions have until today for the material circulation of the forest soils?

To quantify these effects of former forest management the present study is based on three general approaches:

The comparison of present homogeneous stands with different former silvicultural systems.

The comparison of forests that are managed according to different silvicultural systems or intensities including the information about the forestry history.

The comparison of former agricultural used forest stands with present cropland.

Forest sites were divided in different categories with different land use scenarios:

1. Regular Shelterwood after coppice with standards
2. Regular Shelterwood after cropland
3. Regular Shelterwood after selection system

In addition samples will be taken in present ”Bauernwald”, which is a typical management system on small properties devoted to the wood supply of farms, as well as in selection-cutting forests and cropland. First results of the soil investigations will be expected in June and July 2008.

Impact of global change on biodiversity and biogeochemical cycles

1.3. Chemical Ecology of land and water: a trigger for biodiversity

Session cancelled

Impact of global change on biodiversity and biogeochemical cycles

1.4. Ecohydrology – The interactions and feedbacks between ecological and hydrological patterns and processes

Boris Schröder, Britta Tietjen, Eva Nora Müller

Oral presentations

Patchiness, scale and connectivity: understanding ecohydrological interactions in desertification

John Wainwright (1), Laura Turnbull (1), Tony Parsons (1), Jill Stewart (1), Greg Okin (2), Richard Brazier (3) & Eva Müller (4)
(1) Sheffield Center for International Drylands Research, Department of Geography, University of Sheffield, Winter Street, Sheffield, S10 2TN, UK
(2) Department of Geography, University of California, Los Angeles, 90095, USA
(3) Department of Geography, University of Exeter, Amory Building, Rennes Drive, Exeter,Devon, EX4 4RJ, UK
(4) Institut fuer Geooekologie, Lehrstuhl Hydrologie / Klimatologie, Universitaet Potsdam, Karl-Liebknecht-Strasse 24-25, 14476 Golm, Germany

The model of Schlesinger et al. (1990) of mechanisms of desertification has been very influential in guiding research programmes. While it captures many key feedbacks in the process, it essentially focusses on the scale of the individual plant and the surrounding bare area. This focus has led to a significant body of research – including some of our own – that concentrates on the investigation of processes at this plant-interspace scale as a means of understanding desertification. However, it is becoming increasingly clear that not all changes in drylands can be explained by studies at this scale, and that a hierarchy of interactions occur at patch, patch-mosaic and landscapes that all play a rôle, especially in the formation of vegetation patterns. Thus, a scientific approach is required that includes investigations at all these scales.

We describe our attempts to provide this hierarchy of investigations, using plot monitoring, spatial characterization, catchment monitoring, spatial sampling of fluxes and modelling. Although our investigations have been carried out specifically at the Jornada and Sevilleta LTER sites in New Mexico, USA, they provide the basis for a wider understanding of the degradation process in the US Southwest, as well as in other regions. Confronting data at different scales of observation has been a fruitful way of evaluating the limits of process understanding, and the requirements for developing scaling relationships for modelling at large spatial scales. Geostatistical approaches have been integrated in the latter as a way of capturing the process element of moving between different spatial scales. Implementation of process-based models specifically at ecotones has produced some significant results in terms of sensitivity of different types of vegetation boundary at different points in the landscape. Some processes of degradation can be seen to be self-reinforcing at this scale also, while others require external forcing. The spatial connectivity of vegetation and bare areas at different scales within the landscape is a common theme linking all of these investigations. Degradation at landscape scales is controlled by the advection of water, sediment, nutrient and propagule resources by a series of different vectors. A general model for the integrated understanding of these movements has been developed based on the process understanding of connectivity obtained from empirical observations. This model is able to produce observed spatial patterns of vegetation types as a response to different interactions by water, wind and animal movement, and thus provides a more general model for the process of desertification in drylands. All of these approaches can be integrated in a general cusp-catastrophe model linking different types of connectivity with the occurrence of major vegetation change and consequence land degradation.

Integrated modelling of ecohydrological processes along ephemeral rivers

Sven Arnold (1), Sabine Attinger (1), Karin Frank (2) and Anke Hildebrandt (1)
(1) Department Computational Hydrosystems, UFZ – Helmholtz Centre for Environmental Research, Permoserstr. 5, 04318 Leipzig, Germany
(2) Department of Ecological Modelling, UFZ – Helmholtz Centre for Environmental Research, Permoserstr. 15, 04318 Leipzig, Germany

Ephemeral rivers are characterized by temporal surface flows. These floods arise due to highly variable rainfall events in arid regions. For a sustainable resource management the simulation of the vegetation system has to take place by considering the dynamics of the hydrosystem simultaneously. We raise the following question: What are the dynamic interactions between the vegetation and the hydrosystem along ephemeral rivers? The latter includes the stochastic flood regime and the subsurface water storage. In particular, our hypothesis is that there exist mechanisms which buffer adverse effects on the ecosystem.

We present the conceptual framework of an integrated ecohydrological model which describes the dynamic interactions between the hydro- and the ecosystem along the ephemeral Kuiseb River in Namibia. The ecological part of the model is influenced by the hydrosystem by handling the water as a kind of stress factor which affects mortality and growth. On the other hand, the vegetation impacts the hydrological part of the model as a kind of water sink. The model development is an iterative process where hydrological and ecological modelling will be done in parallel and consistently improved when insight into the ecohydrological system and the mechanistic understanding grows. The integration of both disciplines eventually leads to an improvement of the information value for both systems.

The potential use of the model will be its application as a tool for evaluating management scenarios regarding sustainable use of the limited water resource and for identifying adaptive strategies for reconciling conflicts of water use.

Effects of climate change on coupled water-vegetation dynamics in drylands – a simulation study

Britta Tietjen (1), Erwin Zehe (2) & Florian Jeltsch (1)
(1) University of Potsdam, Plant Ecology and Nature Conservation, Maulbeerallee 2, 14469 Potsdam, Germany
(2) Technische Universität München, Institute of Water and Environment, Arcisstr. 21, 80333 München, Germany

In this study we investigate the impact of climate change on coupled water-vegetation dynamics of a semi-arid rangeland. Drylands worldwide are exposed to a highly variable environment and face a high risk of degradation. The effects of global climate change such as increased temperature or more variable precipitation will likely increase this risk. Thus, sustainable land use of these systems e.g. by livestock grazing requires careful planning and detailed knowledge of the system dynamics under climate change.

A suitable way to assess changing dynamics of complex systems is the development and application of simulation models. The high interdependence of water and vegetation in water-limited ecosystems requires the incorporation of key feedback mechanisms between these two components. At the same time, parameter acquisition has to be feasible if the model is intended to be applied to various sites and to draw generic conclusions.

We addressed this task by developing a spatially explicit eco-hydrological model, which strikes a compromise between abstracting to keep its data needs low, and resolving processes where necessary. The water component of the model simulates daily moisture dynamics of two soil layers and surface water. Vertical water movement between these layers, as well as redistribution of surface water by runoff, are taken into account. Vegetation is modelled by the growth of two functional types, namely shrubs and grasses. These compete for soil water and strongly influence hydrological processes.

This talk will introduce our modelling approach through the example of a Namibian thornbush savanna rangeland. We show model validation for present climatic conditions and demonstrate the model’s capability to capture general moisture dynamics. Based on this, we evaluate the effects of altered precipitation patterns and increased mean temperatures on soil moisture patterns as well as on vegetation cover and composition. The results show that increased annual precipitation does not necessarily lead to increased water availability to plants, contrary to assumptions made in many current ecological approaches.

Periodic vs. scale-free patterns: Resolving the dichotomy of dryland vegetation

Ehud Meron (1,2), Jost von Hardenberg (3), Assaf Kletter (1,2), Hezi Yizhaq (1) & Jonathan Nathan (1)
(1) Ben-Gurion University, Institute for Dryland Environmental Research, Blaustein Institutes for Desert Research; Sede Boqer Campus 84990, Israel
(2) Ben-Gurion University, Physics Department; Beer Sheva 84105, Israel
(3) Istituto di Scienze dell'Atmosfera e del Clima, CNR; Corso Fiume 4, I-10133 Torino, Italy

Field observations of vegetation patchiness in drylands reveal periodic patterns with characteristic length scales [1-3] along with scale-free patterns obeying power-law patch-size distributions [4,5]. Despite the numerous theoretical and experimental studies that have been devoted to vegetation patchiness this dichotomy of patterns has remained poorly understood. Using a mathematical modelling approach [6,7] we elucidate the mechanisms that control patch size distributions in water-limited systems, and identify physical and ecological circumstances that lead to periodic patterns and scale-free patterns. Vegetation patchiness in water-limited systems results from water-transport processes that promote the growth of vegetation patches and inhibit the growth in the patch neighbourhoods. We show that short-range inhibition leads to regular patterns with characteristic length scales, while global inhibition leads to scale-free patterns. Global inhibition is favoured when (i) the short-range inhibition induced by water uptake is negligible, and (ii) the time-scale associated with surface water flow is much shorter than the time-scale associated with water infiltration into the soil. We further show that environmental heterogeneities, such as scale-free micro-topographical variations, can override short-range inhibition processes and induce scale-free vegetation patterns. We conclude by discussing the likelihood that observed power-law patch size distributions reflect intrinsic self-organization processes.

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Savanna trees as keystone structures: An ecohydrological view on their impact on grass layer diversity

Anja Linstädter & Thomas van Gerven
University of Cologne, Botanical Institute, Gyrhofstr. 15, 50923 Cologne, Germany

In the water-controlled ecosystems of arid and semiarid savannas, trees are keystone species, increasing species diversity for many taxonomic groups. Many studies found a significantly higher plant species diversity in subcanopy microhabitats. This facilitation is mostly assigned to soil nutrient enrichment, but savanna trees may also alter hydrological properties such as soil available water, and water movement. If soil nutrient enrichment is the most important effect on plant species diversity, positive effects of trees on plant species diversity should be most pronounced in wet years, when water resources are less limiting. If available water is more important, facilitation should be strongest in dry years.

We test this hypothesis on the importance of hydrologically different patches on species diversity with data from a 12-year monitoring study in an arid Namibian savanna. We compare point diversity from subcanopy and open microhabitats for dry, average and wet rain years along a gradient of key structure quality. We further use species-area relationships by means of species area curves and their rates of rise (z-values). Z-values are calculated as scale-to-scale transitions to account for scale dependence. Here we ask if significantly higher slope angles are correlated to areas where keystone tree species occur for the first time.

Results indicate that point diversity shows the strongest differences between subcanopy and open microhabitats in dry years. Species-area relations demonstrate consistent species accumulations in years with good rainfall, in contrast to accelerated species accumulation on different spatial scales in years with average and bad rainfall.

We conclude that particularly in bad rain years, microhabitats below trees serve as hydrological refugia for species with high water requirements. These effects are stronger when keystone structures have a better quality (i.e. trees being less affected by browsing and woodcutting), leading to a higher species richness on spatial scales above 100 m². Our results support other studies which show that the quality of such keystone structures is best detected on medium spatial scales. We discuss implications for a management of water resources and pastures in arid savannas.

Interactions between patterns and processes: hydrological responses to vegetation change over a semi-arid grassland to shrubland transition

Laura Turnbull (1), John Wainwright (1) & Richard Brazier (2)
(1) Sheffield Center for International Drylands Research, Department of Geography, University of Sheffield, Winter Street, Sheffield, S10 2TN, UK
(2) Department of Geography, University of Exeter, Amory Building, Rennes Drive, Exeter, EX4 4RJ, UK

Land degradation is a problem manifest across semi-arid areas world-wide. A common form of land degradation in semi-arid areas world-wide is the invasion of grasslands by shrubs, for example in New Mexico. The change in the distribution of vegetation over the landscape upon a grassland to shrubland transition has significant implications for the hydrological and erosion response to rainfall events. Here, results of field-based monitoring of spatio-temporal soil-moisture content, inter-event hydrology and erosion at stages over a semi-arid grassland to shrubland transition are presented. Monitoring was carried out at the Sevilleta Long Term Ecological Research site, at the northern margin of the Chihuahuan Desert in the south-western United States. Statistical and geostatistical analyses of inter-event soil-moisture content show that there is great spatio-temporal variability in soil-moisture content, which has implications for biotic and abiotic function. Results from event-based monitoring of surface runoff and erosion shows that vegetation structure and spatial properties of soil-surface characteristics has a great influence on runoff and erosion, which will further modify the structure of the ecosystem over the vegetation transition. Results of this study provide further insight into how interactions between vegetation, runoff and erosion propagate further semi-arid vegetation change in ecosystems that are subjected to disturbances that trigger the onset of grassland degradation.

Effect of capillary flux on the soil water balance in a stochastic ecohydrological framework

R. Willem Vervoort (1), Sjoerd E.A.T.M. van der Zee (2)
(1) Hydrology Research Laboratory, Faculty of Agriculture, Food and Natural Resources, The University of Sydney
(2) Soil Physics, Ecohydrology and Groundwater Management, Environmental Sciences Group, Wageningen University and Research Centre, P.O.B. 47, 6700 AA, Wageningen, The Netherlands

Groundwater uptake can play a major role in the survival of vegetation in semi-arid areas. However a simple and accurate analytical description of the groundwater capillary flux as a function of soil water depth and hydraulic properties is not available. We suggest an empirical analytical model to describe the fluxes and include an equivalent piece-wise linear equation for groundwater capillary fluxes into the loss function of an existing ecohydrological stochastic model and derive the probability density functions for soil water saturation. The results indicate the suggested models reflect the impact of increased fluxes due to shallower groundwater on the soil moisture balance very well, and is analytically tractable, to allow calculation of the probability density functions of soil water saturation and water stress. The empirical model is more accurate than two earlier suggested analytical models describing the capillary flux and is easily included into analytical water balance equations.

Coupling ecological and hydrological models

Boris Schröder (1), Erwin Zehe (2)
(1) University of Potsdam, Institute of Geoecology; Karl-Liebknecht-Str. 24/25, 14476 Potsdam, Germany; boris.schroeder@uni-potsdam.de
(2) Technical University of Munich, Institute of Water and Environment, Germany

Landscape ecology and catchment hydrology, both disciplines deal with patterns and processes as well as their interactions and functional implications on a variety of scales. Thus, it is reasonable to study the interplay between ecological and hydrological patterns and processes and to seek for mutual possibilities to assist either discipline in dealing with their respective research questions. Understanding landscape controls on the natural variability of hydrologic processes is a major topic in hydrological research. Quantitative landscape ecology, which aims at understanding the relationships of patterns and processes in dynamic heterogeneous landscapes, may greatly contribute to this research effort by assisting the coupling of ecological and hydrological models.

In the first part, the talk reviews the currently emerging rapprochement between ecological and hydrological research. It points out some common concepts and future research needs in both areas in terms of pattern, process and function analysis and modelling and gives an overview about possible interfaces between ecological and hydrological models.

As an illustration of the interrelations between ecological and hydrological processes, the second part of the talk focuses on an eco-hydrological model that links spatial patterns of anecic earthworm populations, preferential flow pathways and agrochemical transport in rural catchments. Earthworms play a pivotal role in agro-ecosystem functioning by modulating soil structure that significantly influences soil hydraulic properties, organic matter dynamics, and plant growth. Our project focuses on anecic earthworms like *Lumbricus terrestris* which create vertical semi-permanent burrows that function as preferential flow pathways. Preferential flow in macropores is a key process which strongly affects infiltration and may cause rapid transport of pesticides into depths of 80 to 150 cm where they experience a much slower degradation. Therefore, preferential transport is an environmental problem because the topsoil is bypassed, which has been originally thought to act as a filter to protect the subsoil and shallow groundwater. Assessing the environmental risk of pesticides in earthworm burrows and how human management practise feedbacks on that risk requires on the long term the development of an integrated eco-hydrological model.

Impact of eco-physiologically different earthworms on soil water characteristics

Gregor Ernst, Daniel Felten & Christoph Emmerling
Universität Trier, Bodenkunde; Campus II, Behringstr., 54286 Trier, Germany

A laboratory experiment was performed to assess the impact of eco-physiologically different earthworms on soil water characteristics. Four earthworm species (*Lumbricus rubellus*, *Aporrectodea caliginosa*, *Octolasion sp.*, *Lumbricus terrestris*) were exposed in soil columns (30 cm in diameter, 50 cm height) for 100 days with a total fresh earthworm biomass of 22.5 ± 1,2 g per column, each in duplicate. Two columns without earthworms were treated as controls. Each column was equipped with tensiometers and FDR-probes, each in 10 and 40 cm depth, to continuously measure the temporal development of soil tension and soil moisture. Additionally, 30 g of sieved and rewetted horse manure was placed on the soil surface as a litter layer. Precipitation events (10 mm) were simulated at day 28 and 64. At the end of the experiment the water infiltration rate and the runoff in 50 cm depth were determined.

The results showed considerable evidence, that eco-physiologically different earthworms modify soil water characteristics in different ways. Data from soil tension indicated, that the anecic *L. terrestris* seemed to enhance the drying of the top- and subsoil, probably due to an intensified removal of litter from the soil surface and to its deep dwelling behaviour. In contrast, the epigeic *L. rubellus* led to an enhanced storage of soil moisture in the topsoil, which might be affected by an enrichment of organic matter. Both endogeic species, *A. caliginosa* and *Octolasion sp.*, showed high soil dwelling activities and thus led to considerable higher water infiltration rates and to faster water discharge in the subsoil, relative to the other species. Future aspects of this study will help to quantify the effect of different earthworm species on soil water characteristics even under different water conditions in a changing environment.

"Biohydrology" of urban soils

Silvia Pieper (1,3), Oliver Mohnke (2),Thomas Nehls (3), & Gerd Weigmann (1)
(1) Freie Universität Berlin, Soil Zoology and Ecology Lab. Königin-Luise-Str. 1-3, D-14165 Berlin
(2) RWTH Aachen, Applied Geophysics and Geothermal Energy, Lochnerstr. 4-20, D-52056 Aachen
(3) Technische Universität Berlin, Soil Protection Dept. Salzufer11-12, D-10587 Berlin, Germany

The influence of soil fauna on turnover processes and nutrient cycling in terrestrial habitats is fairly well studied. By contrast, the impact of the burrowing, feeding and excreting activity of soil animals on the physical characteristics of soils is far from being understood, even less if we consider anthropogenically shaped environments like urban habitats. Urbanization, though, is a major ongoing land use change worldwide [1], and it is of particular interest to understand the functioning of urban ecosystems and the provision of ecosystem services useful to man in urban areas. The most crucial ecosystem services in cities are the provision of clean drinking water, the reduction of flood risk and the mitigation of climate change consequences, all linked to the capacity of urban soils to infiltrate, conduct, filter and store water from the soil surface. In field studies, the research group INTERURBAN (DFG 409) investigated the importance of heterogeneous soil characteristics for transport processes in urban soils. We paid particular attention to preferential flow patterns, enhanced moreover by the formation of hydrophobic soil patches that dramatically reduce the effective flow path cross sectional area [2]. Aim of the subproject FAUNA within the research group was to characterize the functional impact of soil animals on turnover processes [3] and on the water distribution dynamics in urban soils.

In a series of experiments with mesocosms in field and lab, we studied how the burrowing activity of endogeic earthworms and the mixing of soil particles with excretion products may modify the structure of the soil horizons, the water distribution patterns and the processes of nutrient release in urban soils. The set up of mesocosms equipped with electrodes for the measurements of Electical Resistivity Tomography (ERT) and Time Domain Reflectometry (TDR) probes allowed to trace *in situ* and non-invasively subsequent desiccation, infiltration and rewetting processes in the soils.

The soil animals greatly modified the infiltration and the storage of water in urban soils. This occurred by changing the pore size distribution, increasing the saturated water conducitivity and enhancing the water contents in the soil horizonts. To quantify the influence of the soil fauna on the formation of heterogeneous soil patches, we analyzed the data with geostatistical methods. Interestingly, the specific actual hydrophobicity of the soils was not reduced in presence of earthworms, but the relationship between soil water contents and water repellency was closer and far less variable than in systems without animals. In accompaining experiments with different earthworm species, we could also observe how the animals move through heterogeneous substrates, homogenizing so the soil water content differences between wet and dry soil patches.

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Spatio-temporal modeling of earthworm populations dynamics under changing wetland conditions

Sylvia Moenickes (1), Peter Vorpahl (2) & Otto Richter (1)
(1) University of Braunschweig, Institute of Environmental Sciences; Langer Kamp 19c, 38106 Braunschweig, Germany
(2) University of Potsdam, Institute of Geoecology; Karl-Liebknecht-Strasse 24-25 14476 Potsdam, Potsdam, Germany

Both the influence of earthworms on soils and the influence of soils on earthworms have been studied with the help of experiments and modelling, e.g. concerning macropore density and nutrient availability in the former, toxicity through aridity or heavy metals in the latter respect, e.g. [1], [2],[3], [4], [5].

In this contribution both effects are coupled to a dynamic interaction model for changing environmental conditions. We chose for a spatio-temporal model of a 2D domain, considering a vertical transect, and focussed on wetland dynamics. Soil temperature and humidity have been modelled by means of finite volumes and were used to determine local habitat suitability. The life cycles of earthworms have been modelled by Leslie matrices where soil humidity, soil temperature and population densities have been used to parametrize survival and transition probabilities. The dispersal has been described by a cellular automaton of the domain providing information on population densities for both the life cycle submodel and the soil conditions submodel.

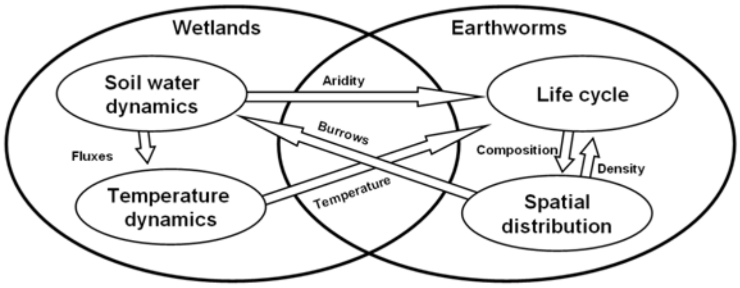

Figure 1: Submodels together with their couplings

The resulting integrated model allowed simulating the spatio-temporal population dynamics of three selected earthworm species at once in a two-dimensional topological context.

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Rainfall partitioning and soil water dynamics along a tree diversity gradient in deciduous forests, Central Germany

Inga Krämer & Dirk Hölscher
University of Göttingen, Tropical Silviculture and Forest Ecology; Büsgenweg 1, 37073 Göttingen, Germany

In forests, rainfall distribution into throughfall, stemflow and interception is influenced by meteorological conditions and stand structural characteristics. Tree species have specific structural traits and species mixtures may create specific forms of canopy niche partitioning. We studied whether rainfall partitioning and soil moisture dynamics change along a tree diversity gradient. The investigation was conducted on twelve plots in old-growth forest stands of the Hainich National Park, Germany. Tree species richness per plot ranged between 1 and 11 species resulting in Shannon diversity indices between 0 and 1.9. *Fagus sylvatica* (beech), which dominates in most natural forests of Central Europe, formed the single-species plots. Mixed forest plots consisted of beech and a variable admixture of other broad-leaved deciduous species such as *Tilia cordata*, *T. platyphyllos*, *Fraxinus excelsior*, *Carpinus betulus*, and *Acer pseudoplatanus*. Throughfall was measured with 15 rain gauges per stand and stemflow was estimated from a total of 50 collectors. Capacitance probes (Sentek) and tensiometers were used for monitoring soil moisture down to 70 cm depth. Median throughfall varied between 67% of gross precipitation (Pg) in a beech stand and 77% in a mixed stand in high-rainfall summer 2007. Throughfall was positively correlated with tree species diversity ($R^2 = 0.45$, $p \leq 0.05$) and negatively with proportion of beech. In the same period we observed a decrease in stemflow from 6% of Pg in a beech plot to 2% in a mixed forest plot. As stemflow reduced and throughfall increased along the gradient, rainfall interception showed little differences among plots. No or weak changes of rainfall partitioning components with tree diversity were observed for the drier summers characterized by lower rainfall intensities (2005 and 2006) and other periods of the year. However, multiple regressions with several stand characteristics including diversity explained up to 73% of throughfall differences between the plots. Data on soil water dynamics showed higher spatial heterogeneity and higher temporal variability in species rich stands. We also have evidence that soil water is used more extensively in forests with high tree species diversity. We conclude that throughfall, stemflow and soil moisture dynamics changed with species mixture, and that there was a strong multiple stand structural control on throughfall volume which included tree species diversity.

New insides into water cycle of the soil-plant-atmosphere continuum including hydration processes of cryptogams

Michael Lakatos (1,3), Britta Hartard (1,3), Matthias Cuntz (2) and Cristina Máguas (2)
(1) Division of Ecology, University of Kaiserslautern, P.O. Box 3049, 67653 Kaiserslautern, Germany
(2) Max Planck Institute for Biogeochemistry, Hans Knöll Str. 10, 07745 Jena
(3) Stable Isotopes Lab., ICAT/CEBV, FCUL University of Lisbon, Campo Grande, 1749-016, Lisbon, Portugal
Email: hartard@rhrk.uni-kl.de

The hydration of the upper vados zone is linked with the vegetation cover reducing soil evaporation by buffering temperatures and turbulences and controlling infiltration and run off of precipitation. In many ecosystems vegetation cover are predominated by poikilohydric organisms such as lichens and bryophytes. Also as epiphytes these cryptogams represent significant impacts on interception and throughfall water in some ecosystems. Thus, cryptogams may play an important role in the soil-plant-atmosphere continuum at climate change scenarios. However, the cryptogamic impact on hydrological processes at these microhabitats/ at the upper vadose zone is largely unknown. Stable isotopes, as natural marker, provide new insides into these water exchange processes influenced by poikilohydric life forms with hygroscopic potential, fast equilibrium with water vapour, and huge water storage capacities. The combination of physiological *in vivo* experiments and field studies *in situ* at temperate, Mediterranean, and tropical habitats revealed surprising pedosphere-biosphere and atmosphere interactions.

The stable isotope composition of oxygen ($\delta^{18}O$) qualitatively traces water exchange processes. Novel data on the $\delta^{18}O$ performance of lichens and bryophytes show that thallus water predominantly isotopically equilibrates with atmospheric vapour (instead of soil moisture?). Hence, thallus water $\delta^{18}O$ of cryptogams reach fast physical equilibrium with the environment and resembles than $\delta^{18}O$ of the surrounding vapour. This performance creates a water saturated interface between soil and plant enhancing soil moisture. Along with first data on organic matter $\delta^{18}O$, these principle achievements provide the basis for applying $\delta^{18}O$ to obtain further information regarding the functioning and performance of cryptogams on ecohydrology. Moreover, the findings stress the potential use of cryptogam organic matter $\delta^{18}O$ as long term indicator and thallus water $\delta^{18}O$ as short term tracer of environmental vapour.

Dense soil layers in the Danube floodplain: do they affect plant species composition?

Maike Heuner, Peter J. Horchler & Elmar Fuchs
German Federal Institute of Hydrology, Department Ecological Interactions, Am Mainzer Tor 1, 56068 Koblenz, Germany

The floodplain of the River Danube between Straubing and Vilshofen (Km 2249 to 2329) is characterized by a complex water budget caused by locally confined groundwater levels. These are due to dense soil layers, with low hydraulic conductivity, consisting of alluvial clay and silt. The German Federal Institute of Hydrology has been in charge of analyzing the correlation between vegetation and abiotic conditions at a study site in this area. A specific research question was "does the weak vertical hydraulic conductivity of sites with dense soil layers affect plant species composition?"

Physical and chemical parameters of all soil layers of 137 soil profiles were estimated in the field and some were measured in the laboratory focusing on hydraulic conductivity as an indicator characterizing soil density. Moreover, plant-sociological surveys were carried out at the soil-sampling sites. Additionally, hydrological parameters such as river and groundwater levels were derived from hydraulic models. Key factors correlating with plant-species composition were identified applying a partial Canonical Correspondence Analysis (pCCA). Subsequently, indicator values of plant species for these key factors were calculated using the IndVal method [1].

The results are:

The composition of vascular plant species at the study site is most strongly correlated with the type of land-use, i.e. grassland / fallow land / forest.

The residual variation in species composition can be explained by differences in surface-water level, groundwater level fluctuation, soil air capacity, and soil hydraulic conductivity (soil density).

However, a plausibility check of calculated indicator values of plant species for the key environmental factors provided little congruence with empirical knowledge of the indicator value of these species.

Despite a very good and detailed database, the analysis yielded results that do not clearly answer the research question. Potential reasons are:

The restricted size of the study area that did not cover the whole floodplain gradient from the river to the dyke may result in undetectable or weak species-environment correlations due to too little environmental variation.

A strong anthropogenic influence at the study site is indicated by the dominance of ubiquitous plant species such as *Urtica dioica, Galium aparine,* and *Impatiens glandulifera*. Consequently, too few specialist species were found that may serve as indicators of site conditions typical of floodplains.

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Impact of salinity and tidal flooding on seedling emergence and establishment – two mesocosm experiments

J. Gesina Engels & Kai Jensen
University of Hamburg, Biocenter Klein Flottbek, Ohnhorststr. 18, 22609 Hamburg, Germany

Estuarine marshes show distinct zonation patterns along the horizontal salinity and the vertical flooding gradient in the Elbe estuary. Species distribution patterns along estuarine gradients are determined by both biotic and abiotic factors. Studies on vertical elevation gradients in salt marshes revealed that lower species borders can be ascribed to physical factors and are therefore affected by the species tolerance towards particular stressors (e.g. salt, inundation) whereas higher species borders are due to competition in a more benign environment and thus determined by the species competitive ability [1]. Similar mechanisms have been found to be responsible for the horizontal zonation of estuarine marshes along the salinity gradient [2]. It is likely that these mechanisms already take effect in the earliest life stages of tidal marsh plants.

We set up two mesocosm experiments to investigate the impact of salinity and tidal flooding on (a) seedling emergence and (b) early establishment of marsh plants germinating from driftline material. Tidal and salinity treatments were adjusted to environmental conditions on low, mid and high elevations in fresh, brackish and salt marshes in the Elbe estuary. The experiments were conducted using 45 plastic tanks that were set up in a greenhouse. We established 3 salinity levels (fresh: 0.5, oligo/mesohaline: 4-8, meso/polyhaline: 15-19) and 3 tidal regimes (flooding twice daily, twice per month, no tide) that were implemented by timer-controlled pumps. Driftline material containing numerous seeds was collected along the salinity gradient of the Elbe estuary in November 2007, stored under cold conditions until spring and added to each experimental chamber in April 2008. In the "seedling emergence experiment" emerged seedlings were counted and removed once per week. By contrast in the "early establishment experiment" the number of seedlings of each species was determined every two weeks and seedlings were not removed. While the first experiment allows us to assess the germination potential as constrained by the prevailing abiotic conditions, the second experiment enables us to follow survival of the seedlings as affected by seedling competition.

Preliminary results indicate that seedling emergence is highest in freshwater treatments without tidal inundation and generally decreases with increasing salinity and tidal inundation frequency. While no freshwater species have been identified in the high salinity treatments so far, salt marsh species can be found over all salinities. Salt marsh species appear to be less productive under fresh conditions than under oligohaline conditions where total number of seedlings is lower. The experiments will be terminated in the beginning of August 2008.

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Poster presentations

Dominance of plant species in Mediterranean marshlands is driven by soil and hydrological constraints

Efrem Batriu (1), Joan Pino (2), Pere Rovira (3) & Josep Maria Ninot (1)
(1) University of Barcelona, Plant Biology Departmen; Av.Diagonal 645, E-08028, Barcelona, Spain
(2) Center for Ecological Research and Forestry Applications (CREAF); Autonomous University of Barcelona, E-08193, Bellaterra, Spain
(3) Centre Tecnològic Forestal de Catalunya; Pujada del Seminari s/n, 25280, Solsona, Spain

The high conservation value of the costal marsh vegetation is widely accepted, but in the Mediterranean basin these ecosystems have been (i) greatly reduced in surface and (ii) altered by human activities. Restoration actions have been proposed, but to ensure their success, a good knowledge of the particular ecological requirements of the most dominant species is needed.

The aim of this study is to gain insight into the soil and hydrological factors that constrain the species distribution and abundance in the Mediteranen coastal marshes. To this end, water table and soil properties have been monitored during 2 and 1 year respectively in 43 vegetation plots in the Llobregat delta (Barcelona). Sampling was designed to catch the maximum spatial and historical heterogenity of this area. The abundance of dominant species has been modelized using GLM and the realized niches have been estimated using those plots where a chosen species was dominant.

Vegetation of this area is dominated by five species: *Phragmites australis*, *Juncus acutus*, *Juncus maritimus*, *Spartina versicolor* and *Arthrocnemum fruticosum*. Flooding (mean water table) and saline stress (maximum conductivity of water table and mean soil Sodium Absorption Ratio) are the most important constraints on the abundance of these five species. GLM can successfully modelize the response of them (i.e. species abundance) to these gradients.

A. fruticosum shows high tolerance to saline stress, but a narrow realized niche in this gradient. *Phragmites australis australis* also shows a narrow realized niche concerning saline gradient due to toxicity problems, but it can ocupy a broader range of flooding conditions. The two *Juncus* species can be considered generalists for both gradients. Finally *S. versicolor* may be considered a specialist restricted to low saline and low flooding regimes. Results also suggest that historic and competition factors may partly explain the distribution and abundance of Mediterranean costal marsh species.

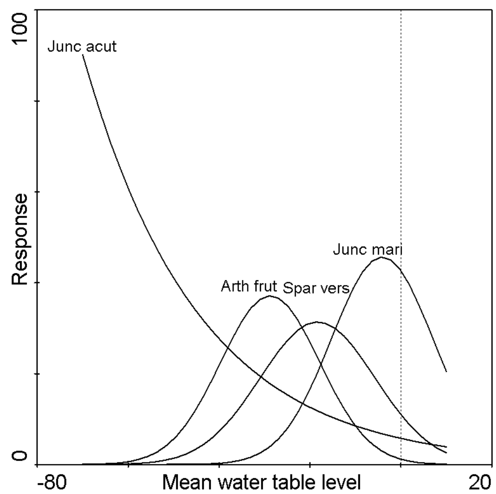

Figure 1: Predicted cover of species along the water table level gradient, according to GLM analyses.

Meteorological effects to above-ground tree growth of a spruce and beech forest

F. Clausnitzer, B. Köstner
University of Dresden, Institute of Hydrology and Meteorology, Pienner Str. 32, 01737 Tharandt, Germany

To determinate the water balance of forests and to get a better understanding of interactions between forest and the environment in the long-term, knowledge about the relationship between tree growth and transpiration is quite necessary, especially for forest management. Both, the altering stem growth and variations in transpiration rates are influenced by atmospheric conditions. Besides these conditions, sufficient soil water supply is the necessary to allow high transpiration rates of the trees. These relationships were observed for the two common tree species, spruce and beech in the Tharandt forest, Germany.

At two experimental sites, Anchor station Tharandt dominated by Norway spruce (*Picea abies* L.) and Anchor station Buchhübel dominated by beech (*Fagus sylvatica* L.), sap flow measurements of several trees are performed continuously by the thermal dissipation technique after Granier since 2001. Stem growth of trees is measured by band dendrometers since 2006. Additionally, long-term flux measurements of carbon dioxide and water vapour (eddy-covariance technique) and standard meteorological parameters are observed.

Relationships between stem growth, carbon flux and transpiration show different results for spruce and beech in 2006 and 2007. These periods include special meteorological events like the low precipitation (11 mm) in July 2006 or the wet but warm period in 2007 which was the warmest year since 1959 with an annual precipitation of 913 mm and annual air temperature of 9.5°C.

This poster will present monthly based relationships between tree growth, stand transpiration and carbon exchange with respect to environmental conditions and different tree species.

Effect of different rainfall on biomass production of forbs and grasses in dry acidophilous grassland

Petr Holub & Karel Fiala
Department of Ecology, Institute of Botany, Academy of Sciences of the Czech Republic, Poříčí 3b, CZ-603 00 Brno, Czech Republic

The results of a macro-scale water balance model show that in 2021-2030, water demand increased world-wide due to the climate change. Rainfall amount and timing have greater impact in current conditions than any other factors. The terrestrial water cycle and the impact of climate changes are critical for agricultural and natural ecosystems. Field experiment was established to quantify the effects of different amounts of rainfall on above-ground production of dry short grassland vegetation in the Podyjí National Park near the town of Znojmo in southern Moravian lowland (altitude 320 m). Roofs constructed above the canopy of grass stand and gravity irrigation simulate three climate scenarios: (1) rainfall reduced by 50 % (dry), (2) rainfall enhanced by 50 % (wet) and (3) the full natural rainfall of the current growing season (ambient treatment). Above-ground production was harvested at the peak of the growing seasons at the maximum of above-ground biomass. Samples were divided to green and senesced biomass and sorted into the following groups: forbs, legumes, narrow and broad leaved grasses, plant litter and mosses.

During two growing seasons 2006 and 2007, enhanced amount of precipitation resulted in an increase of total above-ground plant biomass (up to 345 and 391 g m^{-2}) in comparison with both ambient (262 and 304 g m^{-2}) and mainly dry (250 and 168 g m^{-2}) treatments, however statistically significant only between wet and dry treatments in 2007. This was caused by significantly higher biomass production of forbs in the wet treatment. In the wet treatment, forbs formed 139 and 220 g m^{-2} of above-ground biomass, while only 65 and 64 g m^{-2} in dry treatment in both studied years. Thus, proportion of forbs in above-ground biomass increased from dry treatment (26 and 38%) to wet treatment (40 and 56%) in 2006 and 2007, respectively. On the contrary, no significant effect of treatment was found in total production of grasses. However, proportion of green narrow leaved grasses (mainly *Festuca ovina*) in total amount of green grasses significantly increased in wet (82 and 62%) than in dry treatment (39 and 55%), but significant only in 2006. Obtained results indicate positive effect of enhanced precipitation treatment on biomass of green narrow grasses and forbs and the same trends were also observed when data recorded in wet 2007 and dry 2006 growing seasons were compared.

Bacterial Communities and Microbial Activity in Mediterranean and Central European Streambed Sediments Recovering from Desiccation

Jürgen Marxsen (1,3), Annamaria Zoppini (2) & Sabine Wilczek (1)
(1) Limnological River Station, Max Planck Institute for Limnology, Schlitz, Germany
(2) Water Research Institute, National Research Council, Via Reno, 00198 Roma, Italy
(3) Department of Animal Ecology, Justus Liebig University, Heinrich-Buff-Ring 26-32, 35392 Gießen, Germany

Global climatic change not only affects running waters by increasing temperatures. Discharge becomes more variable as more frequent and severe floods as well as more frequent and longer droughts occur, especially in upper reaches. Mediterranean streams are known to experience droughts in summer[1], but Central European headwaters also are beginning to be affected. We studied the suitability of a sediment core perfusion technique [2] for investigating the development of bacterial communities and the recovery of microbial activity during the first 4 days of rewetting dry running water sediments. We determined bacterial abundance via fluorescence microscopy [3], bacterial community composition by TGGE [4], bacterial carbon production by uptake of radiolabeled leucine [4, 5], and extracellular enzyme activity by fluorogenic model substrates [2].

The bacterial community composition changed only little in the sediments from the Central European stream Breitenbach during rewetting, whereas in the sediments of the Mediterranean Mulargia River (Sardinia) distinct changes were observed, especially within the first day. This difference probably results because the Breitenbach sediments were much less dry than the Mulargia sediments, thus enabling the survival of bacterial communities more similar to typical streambed communities in the Breitenbach. Noticeably high activity levels especially of enzymes involved in polymer degradation (β-glucosidase, peptidase and lipase) were observed at the beginning of rewetting in both environments (more pronounced in the Central European stream than in the Mulargia River). These indicated persistence of extracellular enzymes in the sediments during drought, enabling fast resuming of total microbial activity. After 2–3 days nearly all determined microbial activities reached a level similar to unaffected sediments. However, the process of re-establishment seems to occur faster in the Central European stream, probably because the microbial communities at the beginning of rewetting were more similar to typical stream communities.

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Effects of above- and below-ground competition on germination and performance of floodplain pioneer species

Maria Meyen, Eva Mosner and Ilona Leyer
Philipps-University of Marburg, Department of Conservation Biology, Karl-von- Frisch-Str.8, 35043 Marburg, Germany

In riparian pioneer habitats competition is usually not the decisive factor structuring species composition. Recurrent disturbance by flooding generally prevents increasing competition. Hence, riparian pioneer species are not well adapted to competition and display a weak competitive ability. Due to human interventions in the river floodplains hydrological processes have altered and conditions have become more stabilized, thus, the disturbance-intolerant, highly competitive species are no longer excluded from riparian pioneer habitats.

The potential effects of competition on germination and performance of five floodplain pioneer species (*Populus nigra*, *Pulicaria vulgaris*, *Plantago major* ssp. *intermedia*, *Chenopodium glaucum* and *Rorippa sylvestris*) were investigated in a common garden experiment separating above- and below-ground competition. Six treatments were established: Plant individuals grown with full competition at high and low neighbour density level, with above-ground competition only at high and low density level, with below-ground competition only, or with neither above- nor below-ground competition. Plant performance was evaluated by means of plant height, number of leaves, plant biomass and leaf length. Results indicate a clear negative impact of competition on the pioneer species. Whereas above-ground competition especially reduced germination ability, below-ground competition particularly affected species performance. However, the strongest effects were caused by the interaction of shoot and root competition. Furthermore, the results revealed an effect of neighbour density.

From nature conservational view the results of this study suggest the potential of competition being a threat to the target communities and the dependence of their preservation on maintenance and restoration of natural hydrological conditions and disturbance processes.

Plant Functional Traits in relation to disturbance in salt marshes of Northwest Germany

Vanessa Minden, Michael Kleyer
Universtiy of Oldenburg, Landscape Ecology Group, Faculty of Mathematics and Science, Carl von Ossietzky Straße 9-11, 26111 Oldenburg, Germany

Salt marshes are subject to different disturbance regimes, such as physiological stress caused by high concentrations of salt or mechanical stress created by flooding. As a consequence thereof only a limited number of species is able to colonize this habitat. This study was conducted in salt marshes around the coast of Northwest Germany (Norderland, Leybucht, Jadebusen).

We aimed to identify plant functional groups sharing the same patterns of functional traits as response to different disturbance regimes (flooding, salinity, management). Grouping based on vegetative and generative traits of 14 different species. Selected traits were SLA (Specific Leaf Area), LDMC (Leaf Dry Matter Content), SSD (Specific Stem Density), SRL (Specific Root Length), seed number, and weight of all plant organs.

The role of stable and unstable vegetation boundaries in the propagation of desertification in the American Southwest: A modelling approach

E. N. Mueller (1), J. Wainwright (2), A. J. Parsons (2)
(1) Institut für Geoökologie, Universität Potsdam, Karl-Liebknecht-Str.24-25, 14476 Potsdam, Germany
(2) Department of Geography, University of Sheffield, Winter Street, Sheffield, S10 2TN. UK

Desertification and land degradation in the south-western part of the United States have led to a significant vegetation change from productive grassland to desert shrubland within the last 150 years. Overland flow generated by short, high-intensity rainstorm events has been suggested as having an important role in these land-degradation processes through the redistribution of water and soil resources. To assess the impact of these water and nutrient fluxes on the degradation processes, an event- and process-based, spatially distributed modelling approach was employed in this study. The model implementation was carried out with specific consideration of parameter and process scaling issues at the landscape scale. The modelling studies enabled the quantification of the percentage change of water and nutrient fluxes across vegetation boundaries between shrubland and grassland associations.

The modelling results suggest that landscape linkages through the redistribution of water and soil resources across vegetation-transition zones at the landscape scale and feedback dynamics of overland flow processes play a significant role in the persistent land degradation. It is hypothesised that a vegetation boundary is stable when two conditions prevail that balance the lower resistance of grassland towards the existing environmental setting with the higher resistance of shrubland. First, the soil depletion of nutrients by the action of overland flow in the grassland zone close to the boundary is in balance with the replenishment rates of grassland by nutrient cycling. Second, the grassland gains enough water resources from the upslope shrublands. On the contrary, a vegetation boundary potentially becomes unstable when the grassland acquires a competitive disadvantage towards shrubland regarding water benefit and nutrient depletion due to the combined effects of overland flow dynamics and some external stresses. With reference to the ecosystem stability and resilience theory, the modelling results provided important insights in the potential stability of the grassland-shrubland boundaries as a function of soil-nutrient depletion and water-resource enrichment for the grassland. On the basis of the modelling results, it is hypothesised that external forces such as overgrazing or climatic variations might potentially disturb this boundary-stability scenario, which consequently leads to a unstable vegetation boundary conditions and thus to the invasion of shrubs into the grassland.

Plant functional diversity effects on deep seepage in mountain grasslands differing in land use

N. Obojes (1), M. Bahn (1), E.Tasser (2), U. Tappeiner (1)
(1) Institute of Ecology, Sternwartestrasse 15, 6020 Innsbruck
(2) European Academy Bozen/Bolzano (EURAC) Institute for Alpine Environment, Viale Druso 1, I-39100 Bolzano – Bozennikolaus.obojes@uibk.ac.at

Deep seepage is an important component in the water balance of ecosystems and is a major source of water gained from mountain catchments. We hypothesized that by exerting a decisive control on evapotranspiration vegetation is an important determinant of deep seepage, and that plant functional composition alters deep seepage from mountain grasslands. In 2006, 86 monoliths covering a wide range of plant functional composition were extracted from a meadow, a pasture and an abandoned grassland in the Austrian Central Alps and placed in deep seepage collectors (diameter 25 cm, depth 30 cm) both at the respective sites and at a common garden. Standard meteorological parameters, precipitation at canopy level and soil moisture at rooting depth in each deep seepage collector were logged continuously, and during the growing season (April to October 2007) deep seepage was measured weekly. In addition species composition, cover, height, phytomass and plant area index of functional groups were measured repeatedly for each monolith, and soil physical properties were analyzed. First results indicate that seepage quantity was largely determined by combined threshold levels of precipitation amount and soil water content. When accounting for these overriding effects, large variations were observed that were partly explained by plant cover and height, and were also related to plant functional composition as depending on land management.

Plant distribution patterns and main ecological gradients in six Pyrenean fens

Aaron Pérez-Haase & Josep M. Ninot
University of Barcelona, Dept. Vegetal Biology, Av. Diagonal 645, 08028 Barcelona, Spain

Wetlands are appropriate ecosystems to study the responses of vegetation to environmental gradients, the most obvious of which is the degree of flooding. In alpine, temperate and boreal wetlands gradients such as water mineralization and soil fertility have been pointed out as important factors in plant distribution. In the Pyrenees there is little previous research dealing with this issue. Nevertheless, there are numerous works devoted to classification and description of bog and fen habitats based in floristic criteria. Taking these previous works into account, our main research aims are: 1) To describe in detail six fen systems; 2) To study the main environmental gradients (flooding and water mineralization); 3) To modelize the main species.

The six fen systems are located in the central and eastern Pyrenees, at altitudes ranging from 1800 to 2300 m. These systems, settling on distinct mineral substrata and diversified over varying hydric regimes, held a noticeable diversity of fens and wet meadows. Over the six systems, we selected 340 sampling stations, each consisting of a shallow groundwater well (1 m x 16 mm ø). In each, we measured the oscillation of the water table (during the plant growing season), and pH and electric conductivity of the free groundwater. Then we chose 160 sampling stations to measured cation concentration of the free groundwater samples extracted from the pipes. We made floristic 1 m^2 relevés in each sampling station, and 6,25 m^2 relevés in the stations where we collected water samples. In these stations we also measured peat depth by means of a steel rod. relevés were classified by Fuzzy C-Means algorithm, and ordinated through Correspondence Canonical analyses. We used surface responses to modelize plant species.

The study sites showed different hydric regimes. Mean water table oscillation ranged from 8 to 42 cm. Only *Sphagnum* hummocks and *Sphagnum* carpets generated a rather thick peat horizon. The classification of relevés gave a clear separation between alcaline fens and acidic fens, although it is also obvious the weight of the local species pool in the ordination. This ordination showed a first axis clearly related to water mineralization and a second axis to water table depth. We used the ordination sample scores on these two axes to modelize a selection of fen species. Most of these models were well fitted, and are useful to characterize species distribution patterns on the two main environmental gradients.

Vegetative reproduction capacities of woody floodplain species

Anna Radtke, Eva Mosner and Ilona Leyer
Philipps-University of Marburg, Department of Conservation Biology, Karl-von- Frisch-Str. 8, 35043 Marburg, Germany

One of the striking features of willows and poplars (*Salicaceae*) is their capacity to regenerate asexually under a range of environmental conditions. However, there is only little understanding of the factors controlling abundance and distribution of asexually derived individuals of European softwood forest species.

In two greenhouse experiments, we investigated the effect of biotic (competition) and abiotic (moisture, soil) factors on the performance of cuttings of different woody floodplain species to evaluate species ability to establish vegetatively under different ecological conditions.

In the first experiment, cuttings of four species (*Salix fragilis, Salix triandra, Salix viminalis* and *Populus nigra*) were subject to four competition treatments, with a) above- and below-ground competition from grasses, b) above-ground competition only, c) below-ground competition only, and d) a control without competition. All treatments were conducted under two different moisture levels (moist and water-logged). In the second experiment, cuttings of the former four floodplain species and two additional bog species *(Salix cinerea and Salix aurita)* were grown in three different soils (gravel, loam, bog soil) and under the two different moisture levels (s.a.).

Response variables were length of sprouts, number of leaves, biomass and - the second experiment - root mass. Preliminary results indicate significant differences among treatments. We will discuss how the surveyed factors govern vegetative reproduction, and to what extend they lead to niche segregation among the surveyed species.

Reaction of aquatic vegetation to catchment disturbances based on British rivers

Krzysztof Szoszkiewicz (1), Francis Hugh Dawson (2)
(1) University of Life Sciences, Department of Ecology and Environmental Protection, Wojska Polskiego 28, 60-637 Poznan, Poland
(2) Centre for Ecology and Hydrology, Crowmarsh Gifford, Wallingford, OX10 8BB Oxfordshire, UK

The river vegetation was surveyed in Great Britain, including England, Scotland and Wales with a few sites coming from Northern Ireland. More than one thousand macrophyte stands were recorded from 242 sites of 124 rivers.

Vegetation was classified using TWINSPAN (program for hierarchical ordering of species and samples). Analysis revealed 73 major vegetation types, classified mostly as associations in the phytosociological system. The environmental conditions were described by 68 variables, which included geographical and morphological features as well as river water quality parameters, watershed geology and land use information. The environmental matrix was subjected to principal component analysis (PCA). The identified vegetation communities and environmental data were interrelated with some descriptive analysis based on the mean value, analysis of variance (ANOVA) and also by the multivariate Canonical Correspondence Analysis (CCA). Abundance of plant communities was evaluated against ecological variables, enabling the communities to be ordered against particular environmental factors.

Analysis showed that the river vegetation was significantly differentiated by water quality, as well as by hydromorphology, geography and land use. To some extent, geological data also reflected the differentiation pattern. It was also found that different vegetation groups indicate apparent reaction to the river conditions. The strong relationship between catchment parameters and vegetation was found in case of typical aquatic communities as well as for bank vegetation and also bryophyte and algae assemblages. Analysis enabled classification of river phytosociological communities in the river degradation gradient dividing them into five categories meeting requirements of the Water Framework Directive. Analysis confirmed the specific requirements of different vegetation units which proves their potential for the evaluation of the ecological status of running waters.

Impact of global change on biodiversity and biogeochemical cycles

1.5. Impacts of global change in Mediterranean-type ecosystems

Fernando Valladares

Oral presentations

Antagonistic interaction between climate change and erosion on plant species richness and soil properties in semi-arid Mediterranean ecosystems

Patricio García-Fayos & Esther Bochet
Centro de Investigaciones sobre Desertificación -CIDE- (CSIC-UV-GV)
46470 Albal (Valencia, Spain)

We analyzed the consequences of climate change and the increase in soil erosion, as well as their interaction on plant and soil properties in semi-arid Mediterranean shrublands in Eastern Spain. Current models on drivers of biodiversity change predict an additive or synergistic interaction between drivers that will increase the negative effects of each one. We used a climatic gradient that reproduces the predicted climate changes in temperature and precipitation for the next 40 years of the wettest and coldest end of the gradient and also we compared flat areas with 20º steep hillslopes.

We found that plant species richness and plant cover are negatively affected by climate change and soil erosion which in turn negatively affects soil resistance to erosion, nutrient content and water holding capacity. We also found that plant species diversity correlates weakly with plant cover but strongly with soil properties related to fertility, water holding capacity and resistance to erosion. Conversely these soil properties correlate weaker with plant species cover.

The joint effect of climate change and soil erosion on plant species richness and soil characteristics is antagonistic. That is, the absolute magnitude of change is smaller than the sum of both effects. However, there is not interaction between climate change and soil erosion on plant cover and their effects fit the additive model. The differences in the interaction model between plant cover and species richness supports the view that several soil properties are more linked to the effect that particular plant species have on soil processes than to the quantity and quality of the plant cover and biomass they support.

The evidence that soil erosion affected more negatively plant species richness and soil properties at the cool and wet extreme of the studied climatic gradient than those at the warm and dry extreme indicates that a threshold may exist between the two extremes. Annual rainfall between 350 and 400 mm has been defined as a threshold in rangelands that separates subhumid systems, which are relatively rich in species and are controlled by biotic factors such as plant interactions, microbial activity and organic matter production and decomposition, from poorer arid systems that are controlled by abiotic factors such as lithology and climatic interactions. Above the threshold, perturbations like over-grazing are buffered by a more diverse community (both in species and functional groups) and cause vegetation to change asymptotically around a particular point, which structure and composition are in equilibrium with perturbation regime and environmental conditions. Below this threshold, reduced numbers in species and functional groups don't lead to the recovery of the previous plant community after cessation of grazing or other disturbances.

Our findings suggest that plant species richness is a better indicator than plant cover of ecosystems services related with soil development and protection to erosion in semi-arid Mediterranean climates.

Influence of three co-occurring global change drivers on the survival, growth, phenology and reproduction of a Mediterranean shrub

Silvia Matesanz (1), Fernando Valladares (1,2) & Adrián Escudero (2)
(1) Instituto de Recursos Naturales, CCMA, CSIC, Serrano 115, 28006 Madrid, Spain
(2) Unidad de Biodiversidad y Conservación, Escuela Superior de Ciencias Experimentales y Tecnológicas, Universidad Rey Juan Carlos, c/ Tulipán s/n, 28933 Móstoles, Spain

Global change is not restricted to climate change, and plant species generally face multiple man-driven disturbances constraining their viability (e.g. land use changes). Most importantly, interactions among these drivers frequently generate non-additive effects that cannot be predicted based on single-factor studies. Our goal was to assess the joint effects of three global change drivers that are especially relevant in Mediterranean ecosystems, namely habitat fragmentation, changes in habitat quality, and climate change on Centaurea hyssopifolia, a gypsum specialist plant.

For this purpose, we carried out a two-year study (2005-2006) in natural populations of this plant in two types of fragments (large, mean size 20 Ha and small, mean size 0.6 Ha). Within each fragment, we identified areas of contrasting plant cover and nutrient content as a measure of habitat quality (high and poor habitat quality sites). Finally, we performed a rainfall manipulation experiment simulating the most likely future climate scenario for the region (dry and mesic treatments). The survival, growth, phenology and reproductive success of selected plants was monitored.

The three drivers profoundly affected responses of Centaurea hyssopifolia in both study years, phenology being mainly affected by reductions in habitat quality and reductions in rainfall, and reproductive variables being mainly affected by fragmentation. Plants in poor quality sites and plants in the dry treatment advanced most of their phenophases (flowering and dispersing earlier), and showed reduced growth rate and increased fraction of senescent leaves. Plants growing in small fragments had lower survival, lower number of viable seeds and a reduced seed set than those from large fragments. We found significant synergistic interactions among drivers. For example, the interaction between fragmentation and habitat quality led to lower survival and lower relative growth in plants from small and poor quality sites.

Our results highlight the importance of studies simultaneously involving all relevant drivers of global change affecting plant performance under natural conditions. In addition, the complex responses of phenology and reproductive variables of C. hyssopifolia emphasize the need for studies integrating traits from vegetative to reproductive and from organ to whole plant level.

Process-based models for the range dynamics of plants in a Mediterranean biodiversity hotspot

Juliano Sarmento Cabral, Frank Schurr
University of Potsdam, Institute of Mathematics and Natural Sciences; Maulbeerallee 3, 14467 Potsdam, Germany

Existing statistical models of species distribution are correlative and do not represent the mechanisms driving range dynamics. However, to make reliable predictions for species dynamics under the non-equilibrium conditions arising from environmental change, distribution models have to incorporate ecological processes. Here we develop such mechanistic distribution models to study the range dynamics of Proteaceae endemic to a Mediterranean biodiversity hotspot: the Fynbos vegetation of the Cape Floristic Region (South Africa). Our distribution models incorporate key ecological processes such as local population dynamics, dispersal between patches and local extinction.

The statistical fitting of these models involves three steps: (1) based on a description of suitable habitat, a process-based ecological model simulates the local abundance and the range dynamics of a species in a spatially-explicit fashion; (2) an observation model is used to transform the predicted number of individuals in a habitat into the number of individuals observed (thereby accounting for inaccuracy resulting from the failure to observe all individuals occurring in a survey area); (3) The predictions of the observation model are then used to calculate the likelihood of the spatial distribution of abundances given the model, and model parameters are varied to maximize this likelihood. This approach was successfully tested for artificial landscapes and species.

Hence, we applied it to survey data collected in the Protea Atlas Project for the selected studied species. In our analysis of the Proteaceae data, we (1) considered alternative models for local population dynamics to assess the role of Allee effects and deterministic chaos for range dynamics, (2) applied these models to species with different life-history traits, to test whether persistence strategy and reproductive system have consistent effects on processes driving range dynamics, (3) compared the obtained parameter estimates to independent data. The models were then used to assess the consequences of different conservation management strategies for large-scale species dynamics in a changing environment.

Global change and regeneration ecology of mixed oak forests in southern Spain: field patterns, physiological responses and models

Teodoro Marañón (1), Ignacio M. Pérez-Ramos (1), Itziar R. Urbieta (1), Luis V. García (1), Miguel A. Zavala (2), José Luis Quero (3,4,5) & Rafael Villar (3)
(1) IRNASE, CSIC, Avenida Reina Mercedes 10, 41012 Sevilla, Spain
(2) 2INIA, CIFOR, Madrid, Spain
(3) University of Córdoba, Córdoba, Spain
(4) University of Granada, Granada, Spain
(5) Wageningen University, Wageningen, The Netherlands

Regeneration ecology of mixed *Quercus suber* (cork oak) - *Q. canariensis* (Algerian oak) forests of southern Spain has been studied at different scales and levels of ecological organization. We present results on: 1) species regeneration patterns at regional scale, based on the Spanish Second Forest Inventory data; 2) environmental heterogeneity found at forest stand scale; 3) acorn removal rates along a gradient of canopy cover (light availability) as function of seed size, based on field experiments; 4) patterns of seed germination, and seedling emergence and survival along a combined gradient of light and water availability, based on seed sowing experiments; 5) differential response of oak species to combined treatments of shade and drought, under greenhouse conditions; 6) models predicting oaks' regeneration patterns under different environmental conditions. About 60-70 % of *Q. suber* and *Q. canariensis* stands showed evidences of a limited regeneration in Southern Spain (in Andalusia region). Human management has been a major driver of mixed oak forest composition, expanding the realized niche of cork oak at the expense of that of the Algerian oak. At the stand level, a high variability on soil phosphorus (CV=84%), zinc (76%), and light (54%) reaching the understorey (measured as global site factor) was found. Removal rates of experimentally dispersed acorns increased exponentially with plant cover (measured as leaf area index, LAI). For intermediate values of plant cover, removal rates were higher for cork oak seeds, probably due to their larger average seed size compared to that of Algerian oak seeds. Probability of seed germination and seedling emergence declined exponentially with increasing soil water content during the wet period (autumn-winter) due to heavy rains. Soil waterlogging delayed seedling emergence, which in turn decreased probability of seedling survival during summer drought. Cork oak seeds had a higher germination rate (71%) than those of Algerian oak (47%), but seedling survival was lower (37 vs. 47%). The patterns observed in the field were validated under greenhouse conditions, where the effects of light and water factors were isolated: shade conditions seemed to ameliorate, or at least not aggravate, the impact of drought on oak seedlings. For both species, seed size was more important under shade than under light conditions, in terms of resulting seedling mass. Regeneration models suggest that between-year variation in precipitation may differentially affect oak seedling establishment, promoting species coexistence. Overall, the sensitivity of early seedling life history stages to soil water (waterlogging-drought) and light availability (shade) suggests that predicted changes in the precipitation regime and in temperature-mediated water balance could have major impacts on regeneration dynamics in Mediterranean oak forests.

Is shade beneficial for Mediterranean shrubs experiencing periods of extreme drought and late-winter frosts?

Fernando Valladares (1,2), Joana Zaragoza-Castells (3), David Sánchez-Gómez (1), Silvia Matesanz (1), Beatriz Alonso (1), Angelika Portsmuth (4), Antonio Delgado (5) & Owen K. Atkin (3)
(1) Instituto de Recursos Naturales, CCMA, CSIC, Serrano 115, E-28006 Madrid, Spain
(2) Departamento de Biología y Geología, Escuela Superior de Ciencias Experimentales y Tecnológicas, Universidad Rey Juan Carlos, c/ Tulipán s/n, 28933 Móstoles, Spain
(3) Department of Biology, The University of York, PO Box 373, York, YO105YW, UK
(4) Department of Plant Physiology, University of Tartu, Riia 23, 51011 Tartu, Estonia
(5) Estación Experimental del Zaidín, CSIC, Profesor Albareda 1, E-18008 Granada, Spain

Plants are naturally exposed to multiple, frequently interactive stress factors, most of which are becoming more severe due to global change. Established plants have been reported to facilitate the establishment of juvenile plants, but net effects of plant-plant interactions are difficult to asses due to complex interactions among environmental factors. We investigated how two dominant shrubs (*Quercus ilex* and *Arctostaphylos uva-ursi*) co-occurring in continental, Mediterranean habitats respond to multiple abiotic stresses and whether the shaded understory conditions ameliorate the negative leaf-physiology effects of drought and winter frosts.

Microclimate and ecophysiology of sun and shade plants were studied at a continental plateau in central Spain during 2004-2005, with 2005 being one of the driest and hottest years on record; several late-winter frosts also occurred in 2005. Daytime air temperature and vapour pressure deficit were lower in the shade than in the sun but soil moisture was also lower in the shade during the spring and summer of 2005, and night-time temperatures were higher in the shade. Water potential, photochemical efficiency, light-saturated photosynthesis, stomatal conductance and leaf ^{13}C composition differed between sun and shade individuals throughout the seasons, but differences were species-specific. Shade was beneficial for leaf-level physiology in *Q. ilex* during winter, detrimental during spring for both species, and of little consequence in summer.

Our results suggest that beneficial effects of shade can be eclipsed by reduced soil moisture during dry years, which are expected to be more frequent in the most likely climate change scenarios for the Mediterranean region.

Linking fire response to functional traits in frequently burned stands

Francisco Lloret, Sandra Saura-Mas, Albert Vilà-Cabrera
Author informations missing

Community resilience after fire is determined by species' ability to regenerate through two main mechanisms: growth of new sprouts (resprouter species) and germination from surviving seed banks or from seeds arriving from neighbouring populations (seeder species). Both mechanisms are present in Mediterranean communities. The occurrence of both types in a community depends on fire history and the bio-geographical history determining the available species pool. Here we test if these fire response traits also covary with other functional attributes associated with resource acquisition and stress tolerance. We hypothesize that relevant functional properties of these communities can be determined by the relative abundance of this type of species as a result of particular fire regimes, as expected from field observations and models.

We measured several functional traits of around 30 woody species of the Western Mediterranean shrublands, including leaf traits related with the use of water and nutrients, leaf flammability and combustibility, root system topology, and leaf decomposition. We found that seeder species show more drought tolerance, achieving lower leaf water contents in summer, higher leaf phosphorous content, faster decomposition rate, and more flammable leaves than resprouters. There results support the hypothesis that changes in ecosystem functioning may occur as a consequence of fire regime shifts, as currently observed in the European Mediterranean region, through the modification of species composition, according to their post fire response.

Coupling species vulnerability and ecosystem functioning trends to determine biodiversity sensitive areas to global change

J. Cabello (1), D. Alcaraz (2), E. Liras (1) & J.M. Paruelo (3)*
(1) Dpto. Biología Vegetal y Ecología, Universidad de Almería. La Cañada, Almería. E-04120, Spain
(2) Department of Environmental Sciences, University of Virginia. Clark Hall, 291, McCormick Road, Charlottesville, VA 22904, Virginia, USA
(3) Laboratorio de Análisis Regional y Teledetección, IFEVA, Universidad de Buenos Aires, Av. San Martín, 4453. Buenos Aires. AR-1417 Argentina
**Corresponding author, e-mail addresses: jcabello@ual.es*

Conservation policies need to gain knowledge on the effects of environmental changes on ecosystems and biodiversity to establish geographic priorities. In this sense, monitoring changes in ecosystem functioning may help to fulfil this need due to its direct connection to biodiversity. Functional attributes of ecosystems have a quicker response to disturbances over structural ones, and can be easily monitored with remote sensing at regional scale. In fact, research using satellite-derived functional attributes has revealed a great value for applications in conservation biology, and for assessing ecological responses to global environmental changes. Here, we identified sensitive areas for the conservation of biodiversity against the effects of global change in the Iberian Peninsula, by coupling spatial patterns of threatened species and significant temporal trends on ecosystem functioning. First, we identified those sites with the highest number of threatened species of vertebrates and vascular plants. To do so, we used the information from the "Biodiversity National Inventory". Second, we characterized the baseline conditions and trends of ecosystem functioning, deriving six attributes with biological meaning from the NOAA/AVHRR-GIMMS dataset of the Normalized Difference Vegetation Index (NDVI). This index is a linear estimator of the fraction of photosynthetically active radiation intercepted by vegetation. These six attributes capture important features of ecosystems, such as radiation interception, seasonality, and land-surface phenology. To track the effects of the environmental changes on the priority sites, we sought for temporal trends in the six NDVI attributes along the 1982-2006 period. As a result, we identified sensitive areas that do not necessarily undergo critical environmental impacts. They rather represent a quick shortlist of locations under potential risk of biodiversity loss that deserve further investigation and monitoring. Mountain ranges were identified as particularly vulnerable areas to environmental changes. Specifically, a critical location with a high diversity for vascular plants of conservation concern that undergoes significant changes is Sierra Nevada, a Mediterranean hotspot located at the SE Baetic ranges in southern Spain. For vertebrates, sensitive areas were located in the Mediterranean parts of the Cantabrian Range and in Central Pyrenees in the North Spain. Our study also identified high biodiversity areas with low changes in ecosystem functioning that might be considered as refuges. In particular, the SW of the Baetic ranges might be considered as refuges for vascular plants, but we did not find any of these sites for vertebrates.

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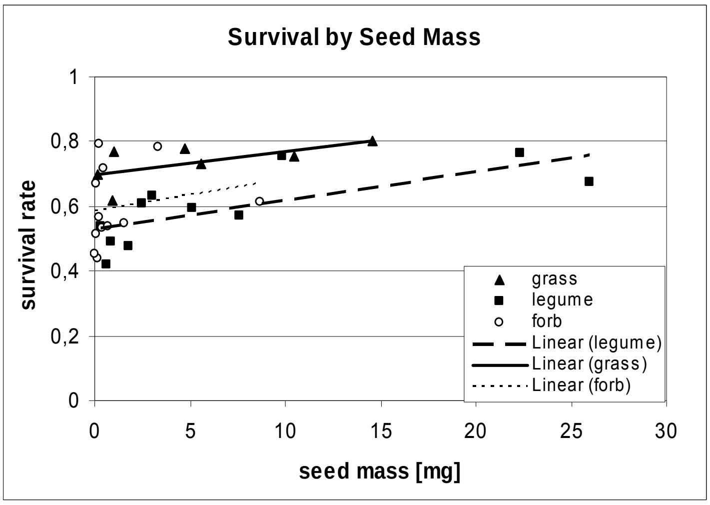
Seed Mass and Dormancy effect the Survival in Mediterranean Annual Plant Communities

Johannes Metz (1), Jaime Kigel (2) & Katja Tielbörger (1)
(1) University of Tuebingen, Dept. of Plant Ecology, Auf der Morgenstelle 3, 72076 Tuebingen, Germany
(2) The Hebrew University of Jerusalem, Faculty of Agriculture, Rehovot Campus, 76100 Rehovot, Israel

The survival of seedlings unto reproduction is a crucial step in a plant's life cycle and effects plant community composition. While an increase in seed mass is correlated with a decrease in seed number, large-seeded species should have higher survival compared to smaller-seeded species since their additional resources render them more resistant to hazards like drought or herbivory. Several studies support the positive correlation between seed size and seedling survival, especially during the first days of seedling establishment. Whether this correlation counts also for survival until reproduction remains unclear. However, most of the studies i) did not work under natural conditions, ii) did not follow survival until reproduction, and iii) included only a small number of species.

Here, we present a seven-years study from a species-rich Mediterranean shrub land in Israel. Each year, seedling-to-adult survival of 30 annual species was obtained from 150 permanent quadrats by species-specific counts of seedlings (at the beginning of the vegetation season) and adults (at the end of the vegetation season), respectively. The average survival was than correlated to the species' seed mass.

Given the 400-fold differences in seed mass between the studied species, their average survival was surprisingly similar and ranged between 40-80%. Additionally, we found a positive correlation between seed mass and survival of all species, though only marginally significant. Most interestingly, by separating highly dormant species (legumes) from low dormant species (grasses) we found a significant difference between these groups: legumes had lower average survival compared to grasses, while within both groups seed mass was again positively correlated with survival.



Our results support that the initial plus in resources gives large-seeded species an advantage beyond the early stages of seedling establishment. Moreover, they demonstrate the importance of dormancy as a risk-spreading strategy on species' survival-rates. Therefore, we discuss our results in the light of life-cycle optimization in order to overcome contradict-tions in the current literature.

Diversity-productivity patterns in experimental and natural Mediterranean grasslands

Akis D. Siamantziouras (1), Giorgos D. Kokkoris (2) & Andreas Y. Troumbis (1)
(1) University of the Aegean, Department of Environment; University Hill, GR-811 00 Mytilene, Greece
(2) University of the Aegean, Department of Marine Sciences; University Hill, GR-811 00 Mytilene, Greece

The relationship between diversity and productivity is a central issue in Ecology. Two distinct thought of schools investigate both observed patterns and underlying mechanisms of diversity-productivity issue at different spatial scales, degree of heterogeneity, disturbance intensity, as well as climate and soil effects. As the "neo-modern" approach, observational studies consider diversity as a function of productivity. Yet, experimental studies have been examining the impact of diversity loss on productivity for the last two decades now, delimiting the "post-modern" approach in this area. Nevertheless, both approaches have led ecologist to long-running scientific debates and animated controversies about the kind of patterns and the type of mechanisms that explain the diversity-productivity relationship. We studied the diversity-productivity relationship in both experimental and natural Mediterranean grasslands. The study sites were located on Lesbos Island in the Aegean Archipelagos, Greece. We conducted both a field experiment using constructed mixed (annual and perennial) herbaceous communities at the Greek BIODEPTH site and an observational study at the nearest neighbouring grassland communities. The effects of diversity (expressed as species richness) on productivity (expressed as annual above-ground biomass) were studied in fifty-two 4-m^2 experimental plots, while the spatial variation in diversity and productivity across a natural soil moisture gradient was studied in twelve 4-m^2 natural plots. The Greek site was the only site of the BIODEPTH experiment where non-significant effects of the loss in species richness upon annual above-ground biomass were identified [1]. Regarding natural grasslands, the results indicated not only that climate change (simulated here in time as the natural soil moisture gradient in space) affected both species richness and annual above-ground biomass, but also that there was no significant effect of annual above-ground biomass on species richness within and across the natural soil moisture gradient. Our results demonstrate a) no diversity-productivity observed pattern in both experimental and natural Mediterranean grasslands, and b) the hump-backed curve as the upper boundary of an envelope of points where the area below the line is filled with data points [2] from both experimental and natural Mediterranean grasslands (Fig. 1).

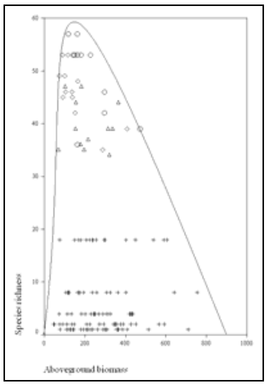


Figure 1: Scatter plot of the species richness as a function of the annual above-ground biomass in experimental (cross symbol) and natural (open symbols) Mediterranean grasslands. The 'hump-backed' curve is fitted by eye.

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[2] Schmid B (2002) The species richness–productivity controversy. *TREE* **17**: 113-114

Poster presentations

Ecology of Mediterranean woody plants in polluted environments: transfer of trace elements from soil to plants, nutritional status and seedling establishment

María Teresa Domínguez, Teodoro Marañón & José Manuel Murillo Instituto de Recursos Naturales y Agrobiología de Sevilla, CSIC Campus Reina Mercedes, PO Box 1052, 41080 Sevilla, Spain

Global change includes soil degradation and pollution. The biogeochemical cycles of natural elements, in particular of trace elements, have been much altered by activities such us mining, agriculture and industry. Despite the increasing importance of soil degradation in a global change context, the possible consequences of trace element pollution for Mediterranean terrestrial ecosystems have not been much studied.

We studied different ecological processes in the soil-plant subsystem in a polluted area in SW Spain. We analysed the transfer of trace elements from soil to the aboveground biomass, for a set of 11 native tree and shrub species. Thus, we could assess the possible risk of bioaccumulation in these species. We also studied the nutrient uptake and nutritional status of the main tree species in the area (*Olea europaea, Populus alba*, *Quercus ilex* subsp. *ballota*). Finally, we studied the survival, growth and establishment of holm oak (*Q. ilex*) seedlings. We combined field observations and experiments, with assays under controlled conditions to study plant responses to these changing environments.

The transfer of the trace elements from soils to the aboveground biomass depended on the element and the species. For eight studied trace elements, Cadmium, Zinc and Copper were the most mobile elements in the soil-plant system. Most of the species showed low trace element concentrations in their leaves [1]. The exception were *Populus alba* and *Salix atrocinerea*, which accumulated up to 1.7 and 7 mg kg^{-1} of Cadmiun and 400 and 800 mg kg^{-1} of Zinc, respectively. Greenhouse experiments confirmed that, for *Q. ilex*, Cadmiun is mostly retained in roots, with a maximum of 0.3 % of translocation from roots to leaves. We detected evidences of negative interactions between soil pollution and P uptake, especially for *O. europaea*. In this species pollution explained a 40% of the variability of leaf P concentrations, and was negatively correlated to the the N:Mg ratio and the leaf chlorophyll content, under field conditions. Under controlled conditions, high concentrations of some trace elements decreased leaf photosynthesis rates, reducing plant growth. However, under field conditions, the bioavailable concentrations were much lower than those concentrations causing deleterious effects under controlled conditions [2]. Thus, other factors rather than soil pollution, such us light and soil moisture, were more determinant for seedling establishment under field conditions.

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The landscape dynamics influence population genetic structure of the endemic plant of Crete *Phlomis lanata* Willd. (Lamiaceae)

Georgescu Luciana, Blaha Juliane, Bariotakis Mihalis, Stergios Arg. Pirintsos
Department of Biology, University of Crete, P.O.Box 2208, 71409 Heraklion, Greece

Genetic diversity is important for the maintenance of the viability and the evolutionary or adaptive potential of populations and species. The wide distribution of the endemic plant of Crete Phlomis lanata Willd (Lamiaceae) mainly on the central and eastern part of the island, the ability of inhabiting altitudes from the sea level to 1600m high, and the apparent absence of physical barriers to dispersal might suggest that the individuals of this species exist as a large, panmictic population. However, the wide variety of Mediterranean habitat types on the island, and the dynamic nature of these habitats over time due to natural phenomena or human influence, could potentially structure Phlomis lanata populations. The genetic structure of Phlomis lanata was analyzed using AFLP across eleven populations situated in different habitat type, covering a range of altitudes from 17m to1462m. We tested whether landscape variables, including topographical distance, elevation, and cover type, were correlated with genetic subdivision (PhiPT) obtained by analysis of molecular variance (AMOVA). Then, in order to test the hypothesis that low-altitude sites, presumably susceptible to sea-level fluctuations, alluvial deposition and human influence, are in general more diverse at the level of genetic complexity than inland sites, we used tree approaches: (i) Mantel tests (ii) the PCoA procedure, and (iii) Sp statistics and spatial autocorrelation. Overall, gene flow appears highly restricted among populations, with a global PhiPT of 0.178 ($P<0.01$). Mantel tests performed over all landscape sections (populations) detected a significant correlation (permutations were set to 9999) ($Rxy=0.196$, $P=0.07$) between the genetic distances matrix and the geographical distances matrix. Spatial autocorrelation revealed clear spatial genetic structure in each population, even though the pattern diminished in older populations. Mean Sp statistics among the populations was 0.0233 and there was only slight variation between the populations, from 0.0119 to 0.0413. Spatially implicit (STRUCTURE) models were used to characterize patterns of landscape genetic structure. All models clustered these populations of Phlomis lanata into four genetically distinct groups, corresponding to Lefka Ori Mountain, Psiloritis Mountain, Anopoli and Skotino geographic regions. These groups were also characterized by different extent of genetic differentiation among populations which reveal more pronounced genetic structure of low-land populations. Our analysis hence suggests that the evolution of the landscape has a significant influence on the structuring of the population under study.

No evidence for local adaptation in thermal and drought responses in Holm Oak seedlings from six contrasting populations

Teresa E. Gimeno (1), Beatriz Pías (1), José Pires Lemos-Filho (2) and Fernando Valladares (1,3)
(1) Instituto de Recursos Naturales, CCMA, CSIC, Serrano 115, 28006 Madrid, Spain
(2) Departamento de Botânica, Instituto de Ciências Biológicas, Universidade Federal de Minas Gerais, Av. Antônio Carlos 6627, 31270-010, Belo Horizonte, MG, Brazil
(3) Universidad Rey Juan Carlos, Área de Biodiversidad y Conservación, C/ Tulipán s/n, 28933Móstoles (Madrid), Spain

Plant populations of widely distributed species experience a broad range of climatic conditions and environmental variability. To face this environmental heterogeneity plants might develop either a high phenotypic plasticity or evolve ecotypic differentiation and local adaptation. We selected six Holm oak (Quercus ilex) populations with contrasting climate and evaluated the response to drought and cold. Acorns collected at the six sites were sown and recorded acorn size was registered together with emergence rate and seedling height. We measured maximum photoshynthetic rate (Amax), instantaneous water use efficiency (iWUE) and thermal tolerance to freeze and heat in five-month old seedlings in optimum (no stress), drought and cold conditions. The observed responses were similar for all populations: drought decreased Amax and increased iWUE, cold reduced both Amax and iWUE. All seedlings maintained photosynthetic activity under adverse conditions (both under drought and under freezing temperatures), and rapidly increased their iWUE by closing stomata when exposed to drought. Heat and freeze tolerances were significantly increased by drought and cold respectively, and we found a significant positive relationship between heat and freeze tolerance. All seedlings showed a very high resistance to both freeze and heat. On the whole, our results revealed a rapid within population adaptability to increasingly stressful conditions and a great general resistance to adverse conditions of the seedlings of this species. We did not find any evidence of a local population differentiation at the ecophysiological level explored despite the contrasting climatic conditions of the original sites of the populations studied. Collectively, our results suggest that phenotypic plasticity coupled with a broad tolerance of stressful conditions and not ecotypic specialization to cope with a fraction of the environmental heterogeneity already experienced by Q. ilex are the means by which this species could face climate change scenarios characterized by extreme temperatures and increased drought and climatic variability.

Monitoring vegetation patterns in Northeastern Morrocco with nested equidistant grids

Gerald Jurasinski (1), Carl Beierkuhnlein (2)
(1) University of Rostock, Institute of Management of Rural Areas, Working Group Landscape Ecology and Site Evaluation; Justus-von-Liebig-Weg 6, 18059 Rostock, Germany
(2) University of Bayreuth, Department of Biogeography; 95440 Bayreuth

In the light of land use and climate change which rapidly alter landscapes and ecosystems worldwide there is an urgent need for standardized and comparable data in order to detect changes of biodiversity. Therefore, it is paramount to provide methods for the comprehensive assessment and evaluation of biodiversity. If biodiversity is lost rapidly at the landscape level, frequent re-investigations are necessary in order to detect and analyze such changes.

We developed a spatially explicit, widely applicable method for the assessment and analysis of phytodiversity, encompassing species richness as well as spatial and temporal heterogeneity of diversity (alpha-, beta-, gamma-diversity) consisting of equidistant nested sampling grids.

These have been applied in a case study in Northeastern Morocco to investigate the drivers of spatio-temporal patterns in vegetation. The nested equidistant sampling grid with hexagonal plots allows for a detailed evaluation of different aspects of biotic diversity on landscape scale. Based on revisits the temporal turnover has been evaluated as well. However, while disturbances play an important role in shaping the emergent patterns of species distribution, the long time disturbance regime, manifested in the coarse vegetation structure, is even more important. Most notably, the relationships between spatial patterns of diversity and their drivers vary with scale and exhibit considerable non-stationarity.

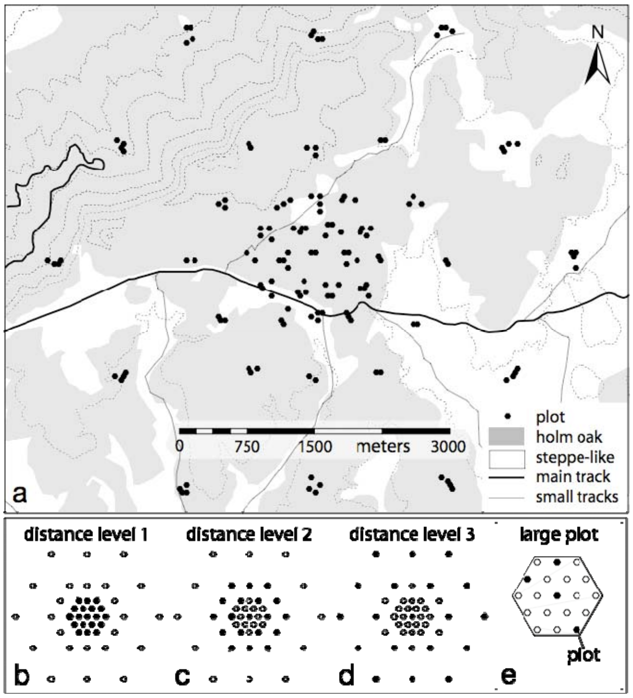

Figure 1. a) Exact geographical positions of the sampled plots on the map. **b-d)** Based on the arrangements of the 43 large plots it is possible to define regular grids of 19 large plots on three distance levels on which the spacing between neighbouring large plots is as follows: **b)** dl1 - 360m, **c)** dl2 - 720m, **d)** dl3 - 1440m. **e)** Each large plot contains a regular grid of 19 plots. They have a side length of 8m (166 m2). Sampling was conducted on 2 to 4 randomly drawn plots of each large plot.

Effects of Global Change on early fitness components and offspring performance of an endemic Mediterranean gypsophile

Beatriz Pías (1), Silvia Matesanz (1), Amaya Herrero (2), Teresa E. Gimeno (1), Fernando Valladares (1) and Adrián Escudero (2)
(1) Instituto de Recursos Naturales, CCMA-CSIC, c/ Serrano 115, dpdo, 28006 Madrid, Spain
(2) Unidad de Biodiversidad y Conservación, Escuela Superior de Ciencias Experimentales y Tecnológicas, Universidad Rey Juan Carlos, c/ Tulipán s/n, 28933 Móstoles, Spain

Maternal environment can influence offspring traits and performance. In natural conditions, plant populations are subject to rapid changes in their natural environment, as a result of simultaneous global changes. Despite these conditions can affect early fitness components, information on the effects of global change on the offspring performance of plant species is virtually inexistent.

Here we analyzed under controlled conditions the combined effect of three drivers of global change (habitat fragmentation, reductions in habitat quality and climate change) on early fitness components and on the offspring performance of *Centaurea hyssopifolia,* a gypsophile shrub endemic to the central Iberian Peninsula.

Fragmentation showed the greatest effects on germination, survival and performance of the seedlings. Seedlings of mothers from small fragments germinated more slowly, showed lower survival or died faster, and showed lower photosynthetic rates under well-watered conditions. Moreover, germination of plants from small fragments was more susceptible to reductions in habitat quality and water shortages in the soil. We did not find seedlings to differ in their plasticity to water stress or in their ability to survive to drought. More than 85% of the seedlings survived until water content in soil was almost inexistent.

These results highlight the key role of global change drivers in the persistence of these populations affecting early fitness components and the performance of the descendants, and the importance of studies involving different factors and global change drivers.

Effects of CO_2 enrichment and increased temperature on tomato and faba bean and their interactions with broomrape

B. Ullrich, P. Högy, J. Grenz , J. Sauerborn, A. Fangmeier*
Institute of Landscape and Plant Ecology, Universtität Hohenheim, Germany
**bullrich@uni-hohenheim.de*

Until the end of the 21st century, the concentration of atmospheric carbon dioxide is likely to increase to approximately 600 µmol l^{-1}. This would strongly contribute to a rise of global mean temperatures by some 2 °C, referring to best-case scenarios (IPCC, 2007). Without doubt these changes of the environment will affect plant growth and ecological behaviour. This may include impacts on yield productivity and quality of agricultural crops, and on their interactions with pests, pathogens or parasitic weeds.

In order to assess the effects of elevated CO_2 concentration and increased temperature on field crops as well as the interaction with parasitic plants, tomatoes (*Solanum lycopersicum*) and faba beans (*Vicia faba*) were grown with and without broomrape (*Orobanche ramosa* and *O. crenata*, respectively) in climate chambers. Plants were exposed to ambient (400 µmol l^{-1}) and elevated CO_2 (600 µmol l^{-1}) in combination with a present and a future temperature profile of Adana, Turkey (mean daily temperatures of 19.7 °C and 21.7 °C, respectively). Effects of each factor (CO_2, temperature, broomrape) on vegetative plant parts and crop yield were observed.

A significant negative effect of higher temperature on vegetative dry weight of both species and on tomato yield was offset by CO_2 enrichment. Elevated CO_2 and temperature also exerted an influence on gas exchange of tomatoes: in some cases, dark respiration (R_d), the maximum rate of carboxylation (V_{Cmax}) and the maximum rate of electron transport (J_{max}) were significantly higher at elevated CO_2. With raised temperature, the mentioned parameters increased under elevated CO_2, but decreased at ambient CO_2 levels. A significant effect of broomrape infection on leaf gas exchange was only found in faba beans, where dark respiration decreased upon *Orobanche* emergence.

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Do young and old trees tell us the same story about climate conditions?

Joana Vieira, Filipe Campelo & Cristina Nabais
Center for functional Ecology, Department of Botany, University of Coimbra, Portugal

Dendroclimatology generally assumes that climate-growth relationships are age independent once the biological growth trend has been removed. Nevertheless, tree physiology changes with age, namely photosynthetic capacity and hydraulic conductivity. This may cause an alteration in climate-growth response over time. We tested whether the radial growth response to climate and the intra-annual density fluctuations (IADFs) of *Pinus pinaster* Ait. changed with age. IADFs are anatomical structures formed in response to changing climatic conditions during the growing season. The radial position of an IADF within the ring is determined by the time the triggering factor occurred, improving the time resolution of the analyses [1].

Trees were sampled in Pinhal de Leiria (Portugal), and were divided in two age-classes: young (<65 years-old) and old (>115 year-old). The IADFs were classified based on the radial position within the ring: Type *E* with latewoodlike cells within the earlywood; Type *L* with earlywoodlike cells within the latewood and type L^+ with earlywoodlike cells between latewood and earlywood of the next tree ring [2].

Earlywood and tree-ring width of young *P. pinaster* trees were more sensitive to climate influence while latewood width responsiveness to climate was stronger in old trees. This could be due to a faster growth rate of young trees or to an earlier growing season start [3]. Thus a time window delay occurs between young and old trees during which the wood cells integrate environmental signals. Additionally, the efficiency of water translocation through a tree decreases with increasing age, due to increasing root to shoot distances, the development of nonconductive heartwood, and the formation of a progressively thinner sheath of new xylem [4]. As a result water deficits may become more pronounced with age and this was reflected in the higher response of latewood width to climate in older trees.

The type and frequency of IADFs can detail the climatic signal during the growing season. High precipitation and temperature in late summer and autumn triggered IADF formation in *P. pinaster*. Young trees showed a higher frequency of IADFs, mainly located in the latewood, being the type L+ the most frequent. The higher the number of cells produced along a radial row, as in young trees, the longer the overall period of tree ring formation. The accumulation of substances in cell walls close to the end of the growing season, when climatic conditions are less favourable can result in IADF formation. In climate reconstruction, it is important to identify age-dependent relationships because they can give different climatic information and in this way detail the climate reconstruction.

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Impact of global change on biodiversity and biogeochemical cycles

1.6. Results of the Project ALARM (Assessing LArge –scale environmental Risks for biodiversity with tested Methods)

Josef Settele, Ingolf Kühn

Oral presentations

ALARM – Risks to biodiversity from climate change

Martin T. Sykes, Thomas Hickler and the climate pillar participants.

In the initial years research within the ALARM climate pillar concentrated into two main areas, assessing and devising improved climate and land use scenarios, and the development and application of methods to assess the risks and impacts of climate change on biodiversity and ecosystems in general. New scenarios were developed taking into account new socio-economic aspects and the results extensively used within the project and elsewhere. With regard to impacts, available biological data at different scales for selected biota were complied including highly sensitive species, fingerprints of climate change analysed and the vulnerability of selected species to range reduction and fragmentation explored. Impacts of climate and land use change on particularly sensitive ecosystems including mountains, Mediterranean, subarctic and freshwater ecosystems were explored through experimentation, observation and modelling. In final years of the project risks to biodiversity were analysed on various levels, including shifts in climatic space and land use, changes in ecosystem structure, and effects on the distributions and population dynamics of species.

Where have the flowers gone? From natural vegetation to land use and land cover types: past changes and future forecasts

Nagy, L. (1), Dendoncker, N. (2), Butler, A. (3), Reginster, I. (4), Rounsevell, M. (2)
(1) University of Vienna, Department of Conservation Biology, Vegetation and Landscape Ecology, Althanstrasse 14, A-1090 Wien, Austria and EcoScience Scotland, 2/1 Glencairn Drive, Glasgow G41 4QP, Scotland, UK
(2) University of Edinburgh, Centre for the Study of Environmental Change and Sustainability, Drummond Library, Room 1, Drummond Street, Edinburgh EH8 9XP, Scotland, UK
(3) Biomathematics and Statistics Scotland, University of Edinburgh, JCMB, The King's Buildings, Edinbugh, EH9 3JZ, Scotland, UK
(4) Department of Geography, Université Catholique de Louvain, Place Pasteur, 3 B-1348 Louvain-la-Neuve, Belgium

The objectives of this work were two-fold: (1) to quantify past changes that have affected the natural vegetation of Europe, and (2) to analyse what rates the model of land use change (MOLUSC, developed in ALARM by Rounsevell et al.) resulted for the alpine zone. Past changes included (a) the quantification of the degree of conversion by human activities of natural vegetation in Europe, and (b) an analysis of the distribution of land use – land cover types in the major zonal (bioclimatic) and azonal vegetation types. Rates of forecast land use change were made by comparing the values produced by MOLUSC; the downscaled results for each of six scenarios and three time scales were compared against the baseline of the aggregated CORINE classes of the year 2000. As climate change and land use are perceived as drivers of equal importance for alpine and arctic environments, we sought an answer to the question if modelling climate change and land use, using climate and land use scenarios developed by the ALARM project indicated similar degrees of change.

The assessment of the extent of modification by land use of each of the main natural vegetation types was made by comparing the model map of natural vegetation of Europe (Bohn et al. 2004) with the GLC 2000 Global Land Cover map (http://www-gem.jrc.it/glc2000/). The analysis has shown that over 40% of the total land area is under cultivation. Some of the main natural vegetation types (mostly lowland and lower montane) have undergone large rates of conversion, while others such as those in the upper montane and alpine zones have been affected little.

A modest rate of change was predicted by MOLUSC in the alpine zone: a slight increase in forest cover (2-5%) and a corresponding decrease in 'grassland' cover. Predictions of climate change alone, based on forecast temperatures using identical scenarios to those employed in MOLUSC suggested a dramatic decrease in the alpine climate zone. A dynamic vegetation model alone (developed in ALARM by Lund University) also indicated a potential high reduction in today's alpine zone. The MOLUSC output suggests a high degree of control on vegetation change by land use in the alpine zone, a zone where land use - land cover maps suggest a low degree of human impact.

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Risk Assessment for Biodiversity: an integrated approach

Serenella Sala & Marco Vighi
University of Study Milano Bicocca, Department of Environmental Science;
Pizza della Scienza, 1, 20126 Milano, Italy

Performing a risk assessment for biodiversity is a difficult task because it covers several issues and most of them suffer for a lack of crucial information. Several indicators have been developed to assess some aspect of biodiversity on the national, international or global scale but they often do not cover the complexity of the problem.[1].This work represents an attempt for developing, within ALARM Project, a tool for biodiversity risk assessment that integrates approaches and results coming from different disciplines (Ecotoxicology, Landscape Ecology, Hearth Sciences). A GIS-based procedure to asses ecotoxicological site-specific risk on biodiversity is described. In particular, the risk from pesticides for aquatic and terrestrial (epigean and hypogean) ecosystems is addressed.

The methodology is based on an integration of databases, algorithms for pesticide exposure evaluation, risks indices, landscape's patch analysis using Geographical Information System for managing models input data and results in a distributed way on the territory. Molecular properties, as chemical-physical and toxicological data of active ingredients, and environmental characteristics, as land use, crop distribution, landscape elements are managed for elaborating and developing realistic application scenarios [2].

The methodology allows calculating exposure and ecotoxicological risk indices for the main organisms representative of aquatic and terrestrial ecosystems. The use of GIS allows accounting for the spatial variability of input data and output results.

The procedure is based on the application of Ecotoxicological Risk Indices, Species Sensitivity Distribution, Indices of Landscape Ecology, Habitat Suitability Indices. All these approaches are integrated, and evaluated in a site specific perspective, in order to assess suitability and vulnerability of ecosystems and to develop site specific landscape maps.

The application of this methodology, and its further implementation (e.g. with meteo-climatic provisional scenarios, with temporal evolution of stressors, with socio-economic assessment), could represent and useful tool in order to combine and optimise provisional risk assessment for biodiversity supporting policy development.

A case history is described, referred to the application of the methodology at different scales (from field to regional) in order to underline the flexibility of the site-specific approach. An example of pesticide risk assessment for biodiversity is presented. The results allow comparing active ingredients to draw a classification of the environmental sustainability of their use, to protect ecosystems and to evaluate vulnerability related to landscape elements.

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[2] Sala S., Vighi M., 2008 "GIS-based procedure for site-specific risk assessment of pesticides for aquatic ecosystems" Ecotoxicology and Environmental Safety, 69(1):1-12. Epub 2007 Nov 1.

Assessing risks for pollinator diversity and pollination services

Ingolf Steffan-Dewenter & Simon G. Potts
Ingolf Steffan-, Population Ecology Group, Department of Animal Ecology I, University of Bayreuth, Germany, contact: ingolf.steffan@uni-bayreuth.de
Simon G. Potts, Centre for Agri-Environmental Research, School of Agriculture, Policy and Development, The University of Reading, UK, contact: s.g.potts@reading.ac.uk

Pollinator diversity is threatened by multiple, potentially interacting factors such as destruction and fragmentation of natural or semi-natural habitats, increasing land use intensification, pesticide use, environmental pollution, invasive species and climate change. The relative importance of these risk factors, and in particular the consequent risks for pollination services, are mainly unknown. Furthermore, risk factors may vary between different habitat types, landscapes and biogeographical regions. In this context the "Pollinator loss" module within the EU-project ALARM aims to: (1) quantify distribution shifts of key pollinator groups across Europe, (2) determine the relative importance of drivers of pollinator loss (land use, climate chance, environmental chemicals, invasive species), (3) measure the economic and biodiversity risks associated with the loss of pollination services in agricultural and natural ecosystems, (4) promote the conservation and sustainable use of pollinators in natural and agricultural ecosystems, and (5) develop predictive models for pollinator loss and consequent risks. In this talk we will give an overview of major findings of the project.

Climate Monitoring and Adaptation in the South American Andes, Integrated Across Regions and Disciplines

Stephan Halloy (1), Karina Yager (2), Carolina García (3), Stephan Beck (3), Anton Seimon (4, Tracie Seimon (5), Julieta Carilla (6), Alfredo Tupayachi (7), Jorge Jácome (8)
(1) Conservation International, Andes CBC, La Paz, Bolivia
(2) Anthropology Dep., Yale University, USA
(3) Herbario Nacional, Universidad Mayor de San Andrés, La Paz, Bolivia
(4) Wildlife Conservation Society, New York, USA
(5) Columbia University, New York, USA
(6) Laboratorio Ecológico de las Yungas, Universidad Nacional de Tucumán, Argentina
(7) Instituto de Investigaciones para el Desarrollo Sustentable de los Agroescosistemas Andios IDSA-ANTARKI, Cusco, Perú
(8) Universidad Javeriana, Bogotá, Colombia

ALARM supported the set up of the first network for monitoring the impact of climate change in the Andes, following GLORIA (Global Observation Research Initiative in Alpine Environments) methodology (www.gloria.ac.at). In addition to establishing GLORIA sites, we initiated interdisciplinary research on a variety of interdependent themes including: mammals, reptiles, amphibians, soil bacteria, glacial retreat, agriculture and animal husbandry [1-3]. There are now six GLORIA sites established in the Andes (four of them with ALARM support), and seventeen more have been identified for development pending new funding. The four ALARM sites are in Perú, Bolivia and Argentina. To these we add comparisons to the highest studied autotrophic plant communities on Volcán Socompa, Argentina. We report on broad geographic, vegetation and climatic patterns for the five research sites while highlighting some of the multidisciplinary branches being explored. The highest vascular plant richness was found in the geologically oldest mountain range, Cumbres Calchaquíes, Argentina, whereas the highest lichen richness was found in the Cordillera Apolobamba, Bolivia, and the highest bryophyte richness was found on the recent fumaroles of the Socompa volcano. Vascular plant species richness is locally determined through geology, grazing, rainfall and other landscape heterogeneity. Thus numbers do not necessarily decline with altitude, creating much richer and complex patterns than in temperate mountains. Lichen species numbers have a tendency to increase with altitude at several sites, again contrary to general assumptions. In contrast to species numbers, cover (or total biomass) decreases dramatically at the highest sites (Orko Q'ocha (Vilcanota), Moraroni (Apolobamba) and Isabel (Cumbres Calchaquíes). Thus, highest sites are characterized by relatively high species numbers, but represented by only a small number of colonizing individuals. Each of these higher sites has been covered in persistent ice or snow in relatively recent times (estimated at a few decades to a hundred years). There are clear indications of upward mobility in plants, vertebrates, cultivation and livestock [2]. Disease organisms are advancing as well, sometimes wiping out the gains in range expansion (amphibians recorded at the highest altitudes in the world, followed by chytrids, [2]). Declining water availability and variability has dried lakes and wetlands (Andean peat bogs) in some areas, with significant changes in species composition and livestock carrying capacity [4].

References?

Spatial mismatch of interacting species in the course of climate change

Oliver Schweiger (1), Josef Settele (1), Otakar Kudrna (2), Stefan Klotz (1), Ingolf Kühn (1)
(1) Helmholtz Centre for Environmental Research, UFZ, Department of Community Ecology, Theodor-Lieser-Str. 4, D-06210 Halle, Germany
(2) Geldersheimer Straße 64, D-97424 Schweinfurt, Germany
oliver.schweiger@ufz.de

Recent climate change has already affected the distributions of many species but future changes are likely to have even more severe impacts. However, climate is only one determinant for the distribution of species but many other factors are likely to contribute, such as dispersal, land cover, and biotic interactions. Considering interactions, climate change may have unexpected consequences when the occurrence of one species is influenced by the occurrence of others. Current studies have evidenced temporal mismatching of interacting species at single points in space. However, we are not aware that the ranges of interacting species may become substantially spatially mismatched.

Based on separate ecological niche models of the monophagous butterfly Boloria titania and its larval host plant Polygonum bistorta, we show that all of three chosen global change scenarios (moderate, intermediate, maximum change) will result in a pronounced spatial mismatch of both species' future niche spaces within Europe. The butterfly may expand considerably its future range distribution (by 124-258%) if the host plant has unlimited dispersal, but it could loose 52-75% of its current range distribution if the host plant is not able to fill its ecological niche, and 79-88% if the butterfly also is assumed to be highly dispersal limited. This approach is expanded on 34 butterfly species and their host plants.

First results strongly suggest that climate change has the potential to disrupt trophic interactions because co-occurring species do not necessarily react in a similar manner to global change, having important consequences at ecological and evolutionary time scales.

The ALARM Focal Site Network: the promise and pitfalls of distributed research

William E. Kunin, Jacobus C. Biesmeijer, , Jens Dauber , Chiara Polce and the ALARM FSN working group.

Institute for Integrative & Comparative Biology, University of Leeds, Leeds LS2 9JT, UK, contact: W.E.Kunin@leeds.ac.uk

Ecologists are increasingly called upon to provide insights and predictions concerning processes operating at national, continental or even global scales. To do so, they generally either extrapolate up from fine-scale field observations performed at a single site, or else rely on coarse-scale correlative database analyses. The ALARM Focal Site Network (FSN) was established to provide an alternative approach: a network of geographically dispersed field sites, within which common observational or experimental protocols could be carried out. In principle, such approaches should allow fine-scale precision but with a broad geographical perspective; a local perspective of processes acting across a continental. The FSN is composed of paired landscapes with contrasting land use patterns in 16 regions across Europe. The research carried out in the first two seasons of the network's existence illustrates both the power of geographically replicated research, and some of the pitfalls involved.

Key results of the project ALARM (Assessing LArge-scale environmental Risks for biodiversity with tested Methods)

Josef Settele, Volker Hammen, Stefan Klotz, Joachim Spangenberg &Ingolf Kühn
Helmholtz Centre for Environmental Research - UFZ; Theodor-Lieser Str. 4, 06120 Halle, Germany

Within this final contribution of the session we plan to summarize the main findings of the ALARM project (funded by the European Commission within FP6; Priority 6, « Sustainable Development, Global Change and Ecosystems »; www.alarmproject.net).

We also present some ideas and plans for future work. We expect that for quite a long period there will still be many outputs from ALARM even after the official termination of the project.

We will focus on the achievements of the development of an integrated large scale risk assessment for biodiversity as well as terrestrial and freshwater ecosystems. Particular focus is put on risks consequent on the interactions of climate change, environmental chemicals, loss of pollinators and biological invasions. One further emphasis is on socio-economic risk indicators related to the drivers of biodiversity pressures as a tool to support long-term oriented mitigating policies and to monitor their implementation.

Poster presentations

Human impact for chemical cycles and biodiversity in peat lands from Kampinoski National Forest

Piotr Gromadka
Author informations missing

Kampinoski National Forest is situated 10 km west of Warsaw, ones of the biggest city agglomeration in Poland. This is a sizeable semi-natural wildness area compressing 55, 000 acres of forest and 44,500 acres of dunes and marshlands. Together with surrounding buffer zone this area has been recognized by UNESCO as a Biosphere Reserve from the year 2000 onward. Area covered by Kampinoski Forest is build of alluvial sandy clastics deposited by Vistula river in the proglacial valley during Late Pleistocene. However, a high level of ground water created favorable environmental conditions for development of an ash-alder forest and typical bog alder forest associated with low moor bog and low moor peat bog soil on the large areas of the floodplain. Proximity humans housing estates surrounding National Forest to exert pressure on all area of forest, especially for the floodplain. First mention about human activity in this area are dating 7 thousand years before present. The last 3 hundred years was a deciding factor for actually appearance. Drainage melioration, robbery management to brought National Forest to ruin. Dramatically anthropogenic influence for water regime caused irreversible changes in floodplain areas. Guidelines research are: how deep human activity change carbon and nitrogen cycles in drainage peat lands, how this changes influence for biodiversity and how it make all of this changes could be put for global climate fluctuation. For investigation was chosen three similar peat bogs, but another degradation degree. Experiment was made in air-condition chamber in control hydro-temperature conditions. Mineral forms, organic compounds soluble in water, and gas emission of nitrogen and carbon was measurement. Remains from core was determined and correlated with radiocarbon dating and with historical human activity dating. Result shows that – all of experimental areas are going in eutrophications way, all lost a typical plants and all increase a lot of carbon dioxide, nitrogen oxide and some of them in especially conditions methane. The major factor to control almost all of processing in drainage areas is a humidity.

The effect of heavy metal pollution on wild bee *Osmia rufa*

Dawid Moroń (1), Hajnalka Szentgyörgyi (1), Irena Grześ (1), Simon G. Potts (2), Ryszard Laskowski (1) & Michał Woyciechowski (1)
(1) Jagiellonian University, Institute of Environmental Sciences; Gronostajowa 7, 30-387 Kraków, Poland
(2) Reading University, Centre for Agri-Environmental Research; PO Box 237, Reading, Berks RG6 6AR, UK

Contamination of natural environment with various products of human activity is a long lasting problem. Negative effects of metal pollution were shown for a number of organisms, including many species of invertebrates. However, most of these studies were restricted to soil dwellers. Much less is known about the effects of metal pollution on organisms not connected directly with soil, but otherwise living in polluted areas. Invertebrate pollinators, especially wild solitary bees, have been studied scarcely despite their crucial role in most terrestrial ecosystems.

We have studied the fitness parameters of the red mason bee *Osmia rufa* along heavy metal pollution gradients. Freshly emerged bees were released along two gradients near zinc smelters one in Poland and the other in England. On the selected sites along the gradients they were provided with reed tubes where females could start their nests. The sites represented a broad range of pollution, from background levels some 20-30 km from the pollution sources, to extremely polluted areas next, to the smelters. At the end of the season the bees' nests were collected and their progeny's development was observed and measured.

We found that females on contaminated sites provisioned their larvae with contaminated pollen and, therefore, they produced less adult offspring. Developing bees fed metal-polluted pollen died more frequently during development, especially males. Higher mortality rates resulted in lower numbers of offspring and, in consequence, smaller populations of reproducing adults in the next season. This, combined with the disturbed sex ratio, will inevitably reduce population numbers of the forthcoming generation.

The pollinator decline observed all over the World may suggest that bees belong to species rather sensitive to environmental changes. We showed that heavy metal contamination is yet another negative effecting added to the long line of factors affected wild bee populations and their interactions with plants.

New electronic journal "*Aquatic Invasions*": an important part of the developing European early warning system on aquatic invasive species

Vadim Panov (1), Stephan Gollasch (2), Boris Alexandrov (3), Kestutis Arbaciauskas (4), Gordon Copp (5), Bella Galil (6), Francesca Gherardi (7), Michal Grabowski (8), Frances Lucy (9), Momir Paunović (10), Mikhail Son (3)
(1) St. Petersburg State University, St. Petersburg, Russia, vpanov@mail.ru, vpanov@aquaticinvasions.ru
(2) GoConsult, Hamburg, Germany, SGollasch@aol.com
(3) Institute of Biology of the Southern Seas, Odessa Branch, Odessa, Ukraine, alexandrov@paco.net
(4) Vilnius University, Institute of Ecology, Vilnius, Lithuania, arbas@ekoi.lt
(5) Cefas, Salmon & Freshwater Fisheries Team, Lowestoft, UK, gordon.copp@cefas.co.uk
(6) National Institute of Oceanography, Haifa, Israel, galil@post.tau.ac.il
(7) University of Florence, Italy, francesca.gherardi@unifi.it
(8) University of Łódź, Łódź, Poland, michalg@biol.uni.lodz.pl
(9) Environmental Services Ireland, Institute of Technology, Sligo, Ireland, lucy.frances@itsligo.ie
(10) Institute for Biological Research "Sinisa Stankovic", Belgrade, Serbia, mpaunovi@ibiss.bg.ac.yu

Aquatic Invasions is an electronic open-access international journal with focus on biological invasions in inland and coastal waters of Europe, North America and other regions (ISSN: 1818-5487, http://www.aquaticinvasions.ru). The journal provides the opportunity of timely publication of first records of aquatic invaders and other relevant information needed for risk assessments and early warning systems. Also, relevant technical reports and conference proceedings can be considered for publication.

Currently *Aquatic Invasions* is serving as an important part of the developing Pan-European early warning system on aquatic invasive species. In 2006-2007, approximately 1500 new records of alien species in European inland and coastal waters were published in 117 papers in 8 regular issues of the first two volumes of the journal. The first records of the highly invasive ctenophore *Mnemiopsis leidyi* in the southern and north-eastern Baltic in 2006-2007 were published in *Aquatic Invasions* less than one month after the authors completed the field work, represents a sound example of the early warning service provided by this online journal.

One of the key benefits of e-journal *Aquatic Invasions* is the timely and readily available publication of essential primary scientific information, also needed for decision-making. This journal may enable timely and coordinated eradication efforts of newly found IAS. Manuscript publication, including a comprehensive review process, takes on average less than one month, thereby reduces the publication time lag typical of many peer review international journals. In addition, *Aquatic Invasions* provides a publication platform for important information on management efforts of invasive species and proceedings of relevant international meetings. Finally, the fast and comprehensive review process of manuscripts serves as effective quality insurance mechanism.

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Impact of global change on biodiversity and biogeochemical cycles

1.7. Macroecology and climate change – Past, present and future

Irina Levinsky, Christian Hof, Anja Rammig, Björn Reineking, Damaris Zurell

Oral presentations

Macroecology and Climate Change: Linking disciplines and scales

David Nogués-Bravo
Museo Nacional de Ciencias Naturales (CSIC), Biodiversity and Global Change Lab, Spain

What shapes species diversity? This question, pointed out by Science as one of the most outstanding scientific questions to be resolved in the coming decades, has fascinated biogeographers and ecologists since the days of Wallace and Darwin. Macroecology has been intensively describing large-scale biological patterns with the promise that they can be explained by a mechanistic evaluation of processes operating at different spatial and temporal scales [1]. Unveiling the hidden drivers of biological diversity is a fundamental objective in order to progress our understanding of the future impacts of Global Change on biodiversity, and to improve the current predictions of future species extinctions. Collaborating with other disciplines such as Global Change Biology, Population Biology, Molecular Biology, Paleocology and Paleontology can be particularly fruitful to Macroecology; not only is it of critical importance to the development of Macroecology as mature discipline, but also because understanding and predicting effects of global change on biodiversity requires integrative studies across spatial and temporal scales.

I will review the current and future trends for testing the effect of past climate changes on Late Quaternary extinctions, and in the patterns of biological diversity: 1) linking CEMs (Climate Envelope Models), population models and aDNA (ancient DNA) to explain past species extinctions [2], and 2) linking paleoclimate information with current global patterns of species richness [3]. I will also discuss 3) the potential routes to develop better predictions of future climate change in species distribution and extinctions because of climate change, this is done by linking CEMs with ecophysiological and functional traits data sets: Mechanistic Climate Envelope Models (MCEMs). Finally, I will highlight why the promise of Macroecology remains unfulfilled: There is a general failure of ecological theory to deal adequately with geographical scale [4].

Documenting mechanisms and testing their effects on emerging large-scale patterns across the whole hierarchy of scales has been only modest, most likely because of the difficulty of incorporating biotic variables at each relevant scale in a rigorous empirical evaluation framework.

The widespread use of correlative approaches. The classical correlative approaches support many times *ad-hoc* explanations of the trends emerging in the results and many of them are merely exercises of curve-fitting in which the mechanisms and processes (such as extinction, speciation or dispersal) are avoided.

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Effects of past climates on latitudinal gradients in plant diversity

Björn Reu (1,3), Axel Kleidon (1), Jack Williams (2) & Sebastian Schmidtlein (3)
(1) Max-Planck-Institute for Biogeochemistry; Hans-Knöll-Str. 10, 07745 Jena, Germany
(2) University of Wisconsin, Department of Geography, 550 North Park Street, Madison, WI 53706, USA
(3) University of Bonn Institute of Geography, Meckenheimer Allee 166, 53115 Bonn, Germany

Latitudinal gradients in diversity (LGD) are reported for contemporary plant species and genera [1,2] as well as for the late Pleistocene and Holocene [3,4]. The slope of the LGD has not been stable over time, thus its dynamics give a potential avenue to evaluate possible environmental controls on its formation (e.g. current climate vs. historical factors). Here we present results from a modelling study that links the diversity of feasible plant growth strategies to prevalent climates (Fig.1).

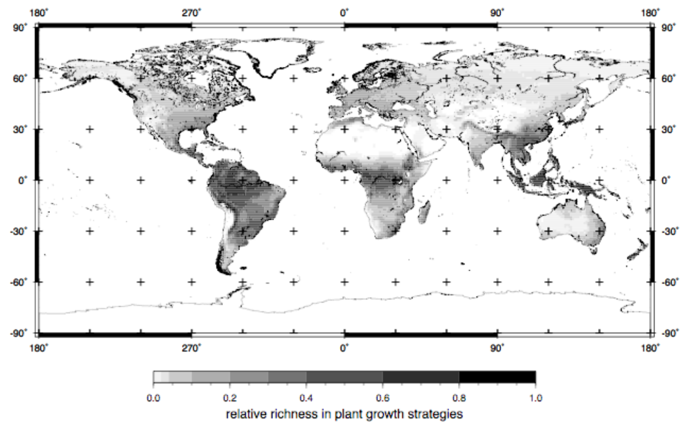

Fig.1 Geographic patterns of the richness of plant growth strategies simulated with a process-based, generic plant model forced with present-day climatic conditions [7]. Richness is expressed as a percentage of the maximum value of species richness found in any locality in the model.

We used an individual based plant diversity model [5] that can predict the geographic distribution of plant species richness based on the assumption that richness mainly reflects differences in plant ecophysiological trade-offs due to climatic constraints. Different climates simulated by a climate model [6] are used to model diversity patterns of the late Pleistocene and Holocene. The analysis of the modeled LGD dynamics is carried out in order to allow for comparisons with past LGD derived from fossil pollen data of Europe [3] and North East America [4]. Since the model assumes equilibrium with climate, the agreement of modeled vs. observed LGD dynamics on glacial-interglacial timescales allow for better understanding the relative contribution of climatic factors on the formation and stability of diversity gradients.

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Global Plant Diversity and Climate Change

Henning Sommer (1), Holger Kreft (1,2), Gerold Kier (1), Walter Jetz (2), Jens Mutke (1), Wilhelm Barthlott (1)
(1) Nees Institute for Biodiversity, of Plants, University of Bonn, Meckenheimer Allee 170, D 53115 Bonn, Germany
(2) Division of Biological Sciences, University of California San Diego, 9500 Gilman Drive MC 0116, La Jolla, CA 92093-0116, USA

Climate change will cause shifts in the size and location of species ranges and in species richness patterns. Contemporary species richness patterns can be explained reasonably well by climatic factors at a macro-scale. However, there is evidence that energy is the most important determinant of species richness at high latitudes, whereas water availability is more important in warmer areas. Based on this water-energy-richness hypothesis, we build a multipredictor model for global contemporary species richness across 1,032 geographic regions worldwide. We analysed the likely impact of climate change on species richness by applying the contemporary relationship between climate and species richness to two contrasting global greenhouse gas emission scenarios promoted by the Intergovernmental Panel of Climate Change (IPCC), in combination with corresponding future climate surfaces from 5 global climate models (GCMs) per 110x110km equal area grid. The moderate B1 scenario indicates an average warming of 1.8°C, while the pessimistic A1FI scenario assumes a global surface temperature rise of 4.0°C by 2100. Our approach allows the spatially explicit quantification of the magnitude and direction of the possible impact of the predicted climate change on the overall distribution of global plant diversity. By 2100, the capacity for species richness per standard area decreases in a global average by 10.4% in the A1FI scenario, whereas it remains similar to today in the B1 scenario (+0.2%). Both scenarios indicate is a strong deviance in the predicted changes amongst different geographic regions. Large proportions of species richness are likely to be not longer supported by future climate conditions especially in many tropical and subtropical drylands and in south-western Amazonia, whereas the capacity for species richness may increase by more than 10% in Arctic and many temperate regions. However, any rapid shift in contemporary climate conditions that causes changes in the capacity for species richness according to our global models may have negative impacts on contemporary floras caused by species turnover and local extinction, and resulting in possible changes of ecosystem functionality.

The Evolution MegaLab: A geographically referenced teaching and learning project

Christian Anton (1), Oliver Bossdorf (2) & Jonathan Silvertown (3)
(1) Helmholtz-Center for Environmental Research -UFZ; Theodor-Lieser Str. 4, 06120 Halle, Germany; E-mail: christian.anton@ufz.de
(2) University of Bern, Institute of Plant Sciences, Altenbergrain 21, CH-3013 Bern
(3) Department of Life Sciences, The Open University, Milton Keynes, MK7 6AA, United Kingdom.

Scepticism and misunderstanding of evolution are widespread among the general public. The occasion of the 200th anniversary of the birth of Charles Darwin in 2009 provides an opportunity to correct this. We will describe a Europe-wide citizen science project called the Evolution MegaLab which is designed to give participants hands-on experience of evolutionary change by inviting them to help in a survey of shell polymorphism in the banded snails Cepaea nemoralis and C. hortensis. The most striking feature of these snails is their array of shell colours and banding patterns. The shells are yellow, pink or brown and can have up to five horizontal bands. Depending on habitat type and environmental conditions, different colours and patterns provide camouflage against bird predators, but also other advantages such as temperature regulation. A website with versions in all of the major European languages has been established (www.EvolutionMegalab.org) that provides background information, instructions and a data base with quantitative historic data on the distribution of Cepaea phenotypes. Data submitted by the public over the web are automatically compared with historical records from nearby locations and participants receive instant feedback on any evolutionary change that may have taken place. Beside science education, this project will help to analyse adaptation processes of banded snails at different temporal and spatial scales. The comparison of the historic distribution of Cepaea phenotypes from the beginning of the 1920s to the late 1980s with the current distribution enables us to understand the dynamics of adaptation in the context of altered land use and climate change.

Habitat and climate cannot explain species richness patterns of European freshwater species

D. Matthias Dehling (1,3), Martin Brändle (1), Christian Hof (2) & Roland Brand (1)
(1) Department of Animal Ecology, Faculty of Biology, Philipps-Universität Marburg, Karl-von-Frisch-Strasse 8, 35032 Marburg
(2) Center for Macroecology, Department of Biology, University of Copenhagen, Denmark; Biodiversity and Global Change Lab, Department of Biodiversity and Evolutionary Biology, Museo Nacional de Ciencias Naturales, Madrid, Spain
(3) Department of Nature Conservation, Faculty of Biology, Philipps-Universität Marburg, Karl-von-Frisch-Strasse 8, 35032 Marburg

Patterns of species richness depend on area, climate, or history. In Europe, lentic (standing water) and lotic (running water) freshwater species show different patterns of species richness. While species numbers of lotic species declines with increasing latitude, richness of lentic species peaks in central Europe. This difference has been suggested to be an effect of the post-glacial re-colonisation due to possible differences in dispersal ability of these two groups. Since standing waters are generally more ephemeral than running waters, lentic species may have evolved a greater propensity for dispersal than lotic species which allowed for a more rapid re-colonization. Species richness, however, increases with area and therefore in freshwater species richness patterns may depend on the area of lentic and lotic habitats. Previous studies failed to consider this possible confounding effect of habitat availability.

In our analysis, we used 25 pre-defined biogeographic regions of the European freshwater fauna to analyse whether species richness of lentic and lotic species is related to habitat availability and current climatic conditions. For each biogeographic region we compiled data on habitat availability and climate from digitised maps [1,2,3] using GIS. We defined habitat availability for lotic species as the summed length of all running waters per region. For lentic habitats we used the sum of the perimeters of all standing waters. Climatic data were averaged over the bioregion.

Availability of lentic habitats increased from southern to northern latitudes, whereas there was no spatial pattern in the distribution of lotic habitats. Hence, species richness was not related to habitat availability neither in lentic nor lotic species. While species richness of lentic species was not related to climatic variables, lotic species richness increased with mean annual temperature and mean annual precipitation, and decreased with increasing seasonality. After controlling for the size of the bioregion, habitat and climate explained 5 per cent of the variation of species richness in lentic species and 40 per cent in lotic species. The geographic patterns, however, remained in both habitat types. Therefore, habitat availaibility and climate are not sufficient to explain richness patterns of lentic and lotic freshwater species in Europe.

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Bird population trends in the Czech Republic in the light of landscape and climatic changes

Jiří Reif (1), Petr Voříšek (2), David Storch (1,3), Karel Šťastný (4), Vladimír Bejček (4)
(1) Charles University in Prague, Department of Ecology, Viničná 7, 128 44 Praha 2, Czech Republic
(2) Czech Society for Ornithology, Na Bělidle 34, 150 00 Praha 5, Czech Republic
(3) Charles University in Prague, Center for Theoretical Study, Jilská 1, 110 00 Praha 1, Czech Republic
(4) Czech University of Life Sciences Prague, Department of Ecology and Environment, Kamýcká 1176, 165 21 Praha 6, Czech Republic

Population trends of birds are driven by long-term modification of major landscape components, and thus are affected by habitat preferences of different species. At the same time, global climate change causes northward movement of species distributions in Europe, probably as a response to shifts of climatic zones. We have examined the effects of these two forces on bird populations using long-term trends in abundance of 103 bird species in the Czech Republic. Population trends are based on annual monitoring data covering time series from 1982 to 2006. The effect of landscape modification has been tested using comparison of birds differing in theirhabitat requirements. They were expressed as categorical variables sorting all species into four habitat groups, and, moreover, we have quantified the association of each species to each habitat using independent data. The effect of climate change was tested using latitudinal distributions of particular species. We sorted each species into four groups according to relative areas of their breeding ranges in the three European latitudinal zones (i.e. boreal, central and mediterranean). Moreover, we calculated latitudinal midpoint of the breeding range of each species. We performed generalized linear modelling to explain variability in population trends by the set of habitat and climatic variables. The latitudinal distribution was better predictor of population trends compared to the habitat category. On the other hand, the habitat association expressed as a continuous variable explained more variability than the latitudinal midpoint. Both analyses showed population decline in species associated with farmland and coniferous forest and in species distributed in higher latitudes. On the other hand, southern species and species of deciduous forest revealed population increase. We conclude that both climate change and landscape change are important factors influencing long-term changes in bird abundance. Their relative effects depend on the way how particular effects are treated, and it is therefore difficult to decide which one is more fundamental. We can also speculate that species association with some habitats would determine its sensitivity to the effects of climate change.

Climate change affects Swiss bryophtes: An example to detect ongoing processes by analysing historical data

Ariel Bergamini (1), Heike Hofmann (2), Stefan Ungricht (3)
(1) Swiss Federal Research Institute WSL, Biodiversity & Conservation Biology, Zürcherstrasse 111, 8903 Birmensdorf, ariel.bergamini@wsl.ch
(2) National Inventory of Swiss Bryophytes NISM, Institute of Systematic Botany, Zollikerstrasse 107, 8008 Zürich, heike.hofmann@systbot.uzh.ch
(3) Swiss Federal Institute of Technology ETH, School Domain S-ENETH, Universitätsstrasse 6, 8092 Zürich, stefan.ungricht@erdw.ethz.ch

A relationship between recent climate warming and observed altitudinal range shifts has been shown for a number of taxa. However, because of a general lack of comparable data, the study of altitudinal range shifts in bryophytes has so far been neglected.

Because of a long tradition of bryofloristic studies in Switzerland, the herbaria contain a large amount of recent and historical bryophyte specimens. In many cases, the labels of the herbarium specimens give detailed information on collection date and altitude. In Switzerland there were two time periods of particularly high collecting intensity: one at the beginning and the other at the end of the 20th century. Here, we use this historical information from herbarium specimens to analyse altitudinal range shifts of bryophytes in Switzerland during the last century.

We used all available records of a total of 199 species and compared the altitudinal information for two different time periods: period 1 from 1880 to 1920 (4070 records), period 2 from 1980 to 2005 (7097 records). The records of both time periods were distributed all over Switzerland and the relative sampling intensity in relation to altitude was very similar for both datasets.

Changes in the mean altitude between the two time periods depend on the ecological requirements of the species: cryophilous species showed a significant increase in the mean altitude whereas thermophilous and intermediate species showed no change. Furthermore, the upper altitudinal limit for most species increased, while there was no clear pattern for the lower altitudinal limit. Nevertheless, at lower altitudes the proportion of records of cryophilous to thermophilous species clearly decreased.

We conclude that two processes are going on, which are presumably driven by climate warming: (1) extinction of populations of cryophilous species in lower regions; (2) colonisation of new areas at higher elevations by both, cryophilous and thermophilous species. We emphasize that historical data are most valuable to analyse ongoing changes in the distribution of species. In that respect, natural history collections in general and herbaria in particular provide a data source of inestimable value.

Cross-scale prediction of climate and land-use change effects on amphibian distribution

Linda Adam (1) & Carsten F. Dormann (2)
(1) Institut of Geography, University Leipzig, Brüderstraße 14 -24, 04103 Leipzig, Germany
(2) Helmholtz Centre for Environmental Research, Department of Computational Landscape Ecology; Permoserstr. 15, 04318 Leipzig, Germany

Climate and land-use change are likely to affect the distribution of many animals and plants. Predicting how species distributions change at the local to regional scale is crucial importance for adaptive conservation management. At the same time, species distribution models that can successfully be used for large-scale (e.g. continental) patterns fail at the local to regional scale, because large-scale drivers often do not show enough regional variation to be incorporated in statistical models at this scale. Hence, based on arguments put forward by Pearson *et al.* (2004, [1]) we analyse the distribution of selected amphibian species at the continental (European) scale *and* the regional (Saxony) in a hierarchical way (Fig. 1). We parameterise the climate niche of the target organism at the continental scale, which provides long enough gradients in temperature and precipitation to include the regional-scale climatic variability. At the regional scale, land-use, soil and topographic information are included to further delimit each species' environmental niche.

This two-scale model is then used to project the occurrence probabilities, together with uncertainty estimations, for the target species to seven different land-use and climate scenarios. To do so, we use combine the projections for climate change based on the European scale and the land-use change projections at the regional scale. Finally, we compare how Global Change scenarios differentially affect amphibians of different ecological adaptations.

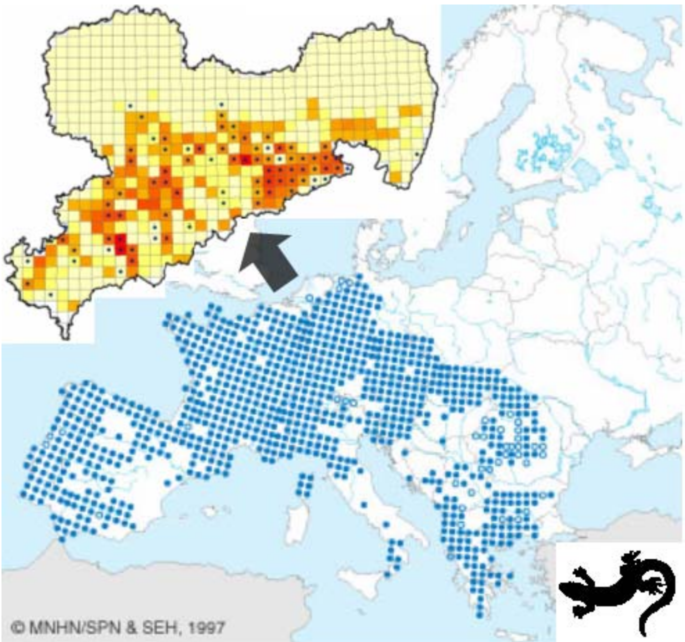

Figure 1: Amphibian distribution on two scales - Europe and Saxony (e.g. *Salamandra salamandra*). Dots indicate presences. Shading levels in the Saxony map are model fits of the hierarchical model. Datasets: http://www.gli.cas.cz/SEH/atlas/amphibians.htm and [2].

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A hierarchical approach to forecasting impact of climate and land-use changes on rare species distribution

Joana Vicente (1,2), Antoine Guisan (3), Christophe Randin (3,4), Angela Lomba(1,2) & João Honrado (1,2)
(1) CIBIO – Centro de Investigação em Biodiversidade e Recursos Genéticos, Portugal
(2) Faculdade de Ciências da Universidade do Porto, Portugal
(3) Spatial Ecology Group, Département d'écologie et évolution, Université de Lausanne, Switzerland
(4) Institute of Arctic and Alpine Research, University of Colorado at Boulder, USA

Environmental, historical and human factors jointly contribute to shape the geographic distribution of plants. These factors can be used as explanatory variables to predict plant distribution within species distribution models (SDM) usually at a same grain size and geographic extent and without specific consideration of their scale of influence. However, factors driving the distribution of organisms are expected to act at different scales, which is best considered in a hierarchic framework. Here, we propose a hierarchic predictive modelling (HPM) approach. We define HPMs as SDMs using subsets of predictors classified by their scale of influence and by the ecological context in which they are hypothesized to operate. These hierarchic subsets of predictors can be applied within a fixed extent and grain setting (as used here) or with multiple grains and extents.

The HPM framework is particularly useful to assess and understand distribution patterns of rare species of conservation importance. So far, still relatively few SDMs have been applied to rare and endangered species, even though their predictions yield useful insights about drivers of species range change, with possible implications for conservation management (e.g. identification of sites with high potential for colonization or risk of extinction). None of these studies have used SDMs in a HPM framework.

Here we illustrate the HPM approach with models for two rare species with contrasting distributions patterns in Northern Portugal, for which distinct subsets of predictors were selected from a common set in the model fitting procedures. We compare the predictive power and the geographic projections of hierarchic and non-hierarchic SDMs, under current and future climate and land use conditions. We show that the hierarchic approach: (i) provides more informative predictions than traditional non-hierarchic approaches, and (ii) allows refined prediction of changes in species distributions.

Scaling of interactions between individuals to landscape patterns

Martin Köchy (1), Florian Jeltsch (1) & Dan Malkinson (2)
(1) University of Potsdam, Inst. of Biochemistry & Biology; Am Neuen Palais 10, 14469 Potsdam, Germany
(2) University of Haifa, Dept. of Geography & Environmental Studies, Mount Carmel, Haifa 31905, Israel

In scaling up, researchers must consider patchiness, interactions, non-linearities, and processes that can be considered constant at one scale may become important at another. A process-aware way of scaling up is to make a model of the scaling process. Results of simulations with validated fine-grained models are condensed by applying formal statistical analyses to quantitative or qualitative relationships with high explanatory power and therefore, reliability. These relationships are then used as instructions in coarser-grained models. The fine-grained simulations must cover the range of conditions expected in the coarse-grain model, either as independent variables or by using scenarios. The condensation may be in time, space, or other units, including individuals or taxa, and can be repeated more than once. For example, we simulated the performance of individual annual plants (grain size 1 cm^2) in semi-arid climates to study the effect of changes in rainfall variability. The density of the seed bank and annual mean water availability were the most important predictors of biomass. In order to simulate the dynamics of annual plants at the landscape scale (grain size 25 m^2), we carried out simulations for a range of classes of seed bank densities in factorial combination with classes of mean annual precipitation (representing climate). The simulated productivity of the vegetation and its variability were expressed as non-linear regressions of five quantiles of productivity on mean annual precipitation for each factorial category (Fig. 1). In the landscape model the annual vegetation was modelled by selecting the appropriate seed bank and climate combination and a random quantile to calculate productivity based on the annual rain volume. This integrated smaller effects of germinability, density-dependent competition, and daily rain variability of the fine-grained model in the coarse-grain model. In a similar way the small-scale dynamics of dwarf shrubs were included in the landscape model. We added grazing by sheep and goats and fire as landscape-scale processes. The landscape model was validated with air photographs. For scaling up the change of vegetation to the scale of countries, we repeated the simulations for characteristic wadi landscapes differing in their slope angle for five climatic regions.

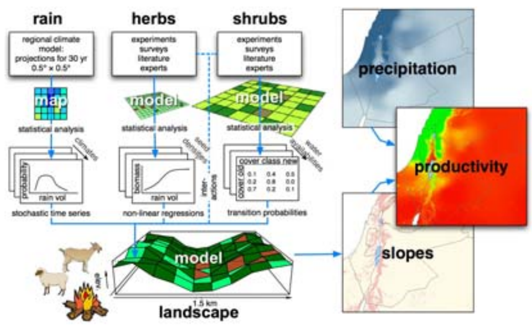

Figure 1. Visualization of hierarchical scaling.

The results were also expressed as non-linear regressions of productivity on mean annual precipitation. The equations were applied to maps of the median slope of the landscape within 1 km^2 (calculated from 90 m DEMs) and mean annual precipitation (Fig. 1). Using this hierarchical modelling approach, we were able to produce country-wide maps of rangeland productivity for various scenarios of climate change and land-use scenarios.

Regional patterns of climate change impacts on plant distribution in Germany

Sven Pompe (1), Jan Hanspach (1), Franz Badeck (2), Wilfried Thuiller (3), Stefan Klotz(1), Ingolf Kühn (1)
(1) Helmholtz-Centre for Environmental Research – UFZ; Theodor-Lieser Str. 4, 06120 Halle, Germany
(2) Potsdam Institute for Climate Impact Research (PIK), P.O. Box 60 12 03, 14412 Potsdam, Germany
(3) Laboratoire d'Ecologie Alpine, UMR CNRS 5553, Université Joseph Fourier, BP 53, 38041 Grenoble Cedex 9, France

Modelling strategies for predicting the potential impacts of climate change on plant distribution have often focused on large scale analyses. Dealing with projected changes, it becomes crucial to assess regional trends of climate change impacts on species ranges. The objective of our study was to analyse changes in ecological niche space of plant species under climate and land use change. Our projections were derived from niche-based models using generalized linear models, generalized additive model and random forests for 845 plant species. We built models at a coarse scale over Europe (50km x 50km) based on climate, soil and land use predictors and projected onto a finer resolution (ca. 11km x 12km) for Germany. Combining these three predictors improved model performance. Modelled species richness (as number per grid cell) was more similar to observed species numbers than patterns resulting from pure bioclimatic model. We addressed the responses of species and plant diversity under three alternative scenarios up to 2080. General results suggest strong effects over the next decades with consequences for the German species pool. Projections are characterised by an increased number of species occupying small ranges. We analysed responses of species loss, gain and turnover with respect to eight ecozones. In particular, eastern and south-western parts of Germany are affected by high rates of species turnover.

Estimating biodiversity at large spatial scale: range concepts matter

Claudia Raedig (1) & Holger Kreft(2,3)
(1) University of Leipzig, Department of Systematic Botany; Johannisallee 21, 04103 Leipzig, Germany
(2) Nees Institute for Biodiversity of Plants, University of Bonn
(3) Ecology Behavior & Evolution Section, Division of Biological Science, University of California, San Diego University

The estimation of biodiversity is a first step when assessing possible impacts of global change on biodiversity. At large spatial scale, species richness per unit area is a prevalent surrogate for measuring biodiversity. Species richness estimations rely on species occurrence data. Even high-quality occurrence datasets are limited regarding both incomplete documentation of occurrences per species and incomplete documentation of the number of species occurring in an area. Thus, range concepts to complement limited distribution data have to be selected to construct species geographic ranges from species occurrence data. An overlay of these geographic ranges yields species richness maps.

We compared the influence of different range concepts using the diverse palm genus *Bactris* in the Neotropics where both revised point-to-grid data and expert range data were available. Point-to-grid ranges were generated by merging species point occurrences to a grid. Expert ranges were constructed considering all available information on the respective taxon and area. Convex polygons, a technique used by the IUCN to generate species geographic ranges for endangered species, were generated by creating the convex hull around the point-to-grid occurrences. Modeled species ranges were created using the MAXENT algorithm which has been shown to perform well in cases of presence-only data and low numbers of species occurrences. Range size frequency distributions (RSFDs), spatial autocorrelation, species richness maps and congruency of pair-wise species richness variables were compared at spatial resolutions varying between 1 and 5 degrees.

SFDs and species richness maps resulted in two extremes: most point-to-grid ranges were small and the point-to-grid richness map was porous with comparably small centers of species richness. In contrast, the convex polygon richness map displayed coherent and large centers of species richness. Expert and modeled ranges were ranked between those extremes. Spatial autocorrelation was lowest for point-to-grid ranges and highest for expert ranges. When compared pair-wise, highest congruency was found between expert ranges and convex polygons as well as between expert and modeled ranges. Decreasing of spatial resolution of the richness maps yielded a higher similarity between richness maps.

In summary, comparison of underlying range concepts showed far reaching differences: Whereas point-to-grid ranges tend to under-estimate species ranges and richness, convex polygons over-estimate, with expert and modeled ranges ranking in-between. Modeling automatically excluded species with only few occurrences from analysis, thus making modeled ranges the least applicable range concept to infer biodiversity of endangered species, which are most prone to global change.

Habitat suitability models: how suitable are they?

Wilfried Thuiller & Cécile Albert
Laboratoire d'ecologie Alpine, UMR CNRS 5553, Université Joseph Fourier, BP 53, 38041 Grenoble Cedex 9, France

Habitat suitability models, also called niche-based models, ecological niche models or bioclimatic envelops, have been extensively used over the last ten years to project the likely effects of climate change on species distribution or the spread of invasive species across natural habitats. A quick search in ISI Web of Science (18/02/08) using "Species distribution models" OR "niche models" OR "habitat models" OR "bioclimatic models" highlights 21,973 papers, 74% of which published in the past 10 years.

By relating occurrence data to relevant environmental factors, those models supposedly rely on the ecological niche concept which expresses the suitability of habitat for a particular species (probability of occurrence). This habitat suitability has been originally defined as any location allowing a population growth rate > 1. Although this definition is subject to debate (e.g. source-sink relationships), it provides interesting opportunities for test hypotheses. In this paper, we present the first empirical test of the generality of habitat suitability models to effectively describe population processes such as fecundity, growth and abundance. We used an extensive dataset of tree growth and survival for more than 20 species over 16,000 plots in the French Alps. We first built habitat suitability models using the latest developments in distribution modeling and adequate environmental variables to predict the suitability of each species of each plot. We then related these probabilities to measured growth, fecundity and abundances. Given the hypothesis that environmental variables describe the conditions for growth, fecundity and abundance, historical legacies, local conditions and disturbance are thus expected to create a broadly triangular relationship between habitat suitability and population processes with a positive sloping hypotenuse. Since conventional regression-correlation analyses are inappropriate to test relationships where the variance of the response variable changes with values of the controlling factor, other forms of analysis are required. To quantify this, we employed non-linear quantile regression based on least absolute value models and using data points in the 0.75, 0.85 and 0.95 quantile.

The striking results are the inappropriateness of commonly used habitat suitability models to express population processes and question their overuse to tackle climate change problems. HSM are nevertheless useful to discriminate presence and absence. We conclude by proposing some alternatives and research opportunities to address this problem.

Can static models depict dynamic populations? A virtual experiment

Damaris Zurell (1), Florian Jeltsch (2), Carsten F. Dormann (3) & Boris Schröder (1)
(1) University of Potsdam, Institute of Geoecology; Karl-Liebknecht-Str. 24/25, 14476 Potsdam, Germany, damaris.zurell@uni-potsdam.de
(2) University of Potsdam, Institute for Biochemistry and Biology
(3) UFZ Helmholtz Centre for Environmental Research, Department of Computational Landscape Ecology

Species are expected to respond to climate change by distribution shifts. Reliable predictions of such range shifts are crucial for dynamic and sustainable conservation strategies, and are thus major challenges in ecological research. Statistical species distribution models (SDMs) have been widely used to predict species occurrence in space and also in time. Nevertheless, their applicability for climate change projections remains questionable as they implicitly assume (pseudo) equilibrium, and do not explicitly incorporate dispersal, demographic processes and biotic interactions. Here we conducted a virtual simulation experiment to assess the accuracy of SDM projections under climate change when species are undergoing transient dynamics, and the effects of ecological processes on these accuracies. For this purpose, we built a spatially explicit multi-species dynamic population model incorporating species-specific and interspecific ecological processes, environmental stochasticity and climate change. A virtual ecologist sampled species distribution in different scenarios. SDMs were estimated applying different modelling methods, Generalised Linear Models (GLMs), and Boosted Regression Trees (BRTs). Spatial and spatiotemporal predictions were made, and prediction accuracies were then related to underlying ecological processes and transient dynamics.

Under average climate, SDMs were transferable in space and in time. Prediction accuracies varied depending on ecological traits and processes, but were similar for GLMs and BRTs. Model transferability in time decreased when species shifted their range due to climate change. However, when distinct range contractions occurred, models yielded good prediction accuracies because species absences were predicted well.

Explaining geographical patterns of prediction errors

Jan Hanspach, Ingolf Kühn, Oliver Schweiger & Stefan Klotz
Helmholtz Centre for Environmental Research, Department of Community Ecology,
Theodor-Lieser-Str. 4, 06120 Halle/Saale, Germany

The importance of predictive distribution models increased over the last years due to an increasing demand to understand and quantify the possible effects of climate and land use change. It is well known, that the prediction error which is inherent to suchlike models, varies considerably between modelling algorithms and between species. Thus prediction errors are not evenly distributed over space and, since input datasets are often grid data, errors may depend on the characteristics of the grid cells.

We modelled the distribution of more than 1000 vascular plants in Europe using presence/absence data from Atlas Florae Europaeae and data on recent climate (1961-90) with generalized linear models. We derived modelled presence/absence values and compared them with the observed species distributions. For every grid cell we calculated the rate of false absence and false presence. We used linear models in order to quantify the association between the resulting rates of false absence and false presence with grid cell characteristics regarding topography, land cover, human influence and range characteristics of the occurring species.

The prediction error increased with the heterogeneity within a grid cell (altitudinal range, number of land cover types), range size rarity and with the frequency that a grid cell is at a range edge. Our results may serve as an input into Bayesian frameworks to account for spatial uncertainty a priori while modelling species distributions.

Response of forests to combined climate and land use changes: examples from Switzerland and Europe

Niklaus E. Zimmermann (1), Jacqueline Gehrig-Fasel (1), Sophie Rickebusch (2), Gillian Rutherford(1), Mario Gellrich (3),Heike Lischke(1) & Peter B. Pearman (1)
(1) Swiss Federal Research Institute WSL, Land Use Dynamics; Zürcherstr. 111, CH-8903 Birmensdorf, Switzerland
(2) Université J. Fourier, Laboratoire d'Ecologie Alpine, F-38041 Grenoble Cedex 9, France
(3) Swiss Federal Institute of Technology ETHZ, Terrestrial Ecosystems, CH-8092 Zürich

The distribution of trees in Europe may undergo significant changes over the next decades and centuries in response to ongoing climate and land use change. Generally, species are expected to migrate to higher elevations, and in many areas, more drought tolerant species may establish as a function of a forecasted decrease in summer precipitation. Yet the re-adjustment of trees and forests to the forecasted changes may be lagged considerably compared to the changes in climate. On the one hand, the migration of long-lived species such as trees is a slow process. On the other hand, the control of humans on land and its use represents a second obstacle for rapid re-adjustment of the tree distribution to climate change. On top, land use is currently changing as well, partly at a rapid pace. Demonstrating the combined effects of changing land use and climate upon trees is the goal of the presentation, illustrated with results from Europe and Switzerland.

First, we demonstrate how the potential distribution of individual trees is expected to shift in space and along altitudinal gradients, to what degree future ranges are overlapping with current ranges, and to what degree ranges are likely to expand or shrink in response to IPCC scenarios. Results indicate, that some species will barely have overlap between future and current ranges under extreme scenarios, and that some ranges are expected to shrink considerably (e.g. *Fagus sylvatica* and *Picea abies*). At the same time, land use is changing fast with a rapid conversion of open land into both urban and forest classes. Results show that open land abandonment and conversion to forests totals e.g. to 16 ha daily in Switzerland. Thus, the forest matrix is undergoing additional changes, and this may facilitates the re-adjustment to climate change locally. As a result, the treeline is moving upwards at a slow pace in the European Alps.

Second, we demonstrate how both climate and land use change interact. Our analyses demonstrate that most of the observed upward shifts are likely due to land use change, outweighing the response to climate change. The latter is visible, but only at a very slow pace of few meters annually. This is by far slower than the recent change in the potential treeline, which has reached more then 200m in elevation over the last two decades. Dynamic simulation runs of the spatially explicit TREEMIG model that include both climate and land use change as scenarios confirm these observations. Our results indicate that land use exerts a strong control over the spatial dynamics, and that both with and without land use change, forests are expected to lag significantly behind their potential range shifts. This result was obtained both under extreme and under moderate climate change scenarios.

From ecosystems to species

Thomas Hickler (1), Katrin Vohland (2), Benjamin Smith (1) & Martin T. Sykes (1)
(1) Department of Physical Geography and Ecosystems Analysis, Geobiosphere Science Centre, Lund University, Sölvegatan 12, S-223 62 Lund, Sweden
(2) Potsdam Institute for Climate Impact Research, Telegraphenberg A 62, D-14473 Potsdam, Germany

Empirical models for projecting species distributions and biodiversity have been heavily criticized and more mechanistic, process-based approaches have been advocated. We suggest that the ecological data for parameterizing large numbers of species will not be available in the near future and present a different approach for using process-based models to improve projections of climate change impacts on species. With two example studies, we show how the ecosystem structure predicted by a detailed process-based vegetation/ecosystem model can be translated into information on habitat type and quality, with implications for all species.

In the first study, we used a dynamic vegetation model (LPJ-GUESS), parameterized for widely distributed tree species and plant functional types, to simulate transient changes in the potential natural vegetation across Europe until 2100 under four climate change scenarios. The model projected considerable shifts in vegetation types in most areas across Europe: 19 – 42% of the total area of Europe and similar fractions of the area protected by the Natura 2000 network might be covered by a different vegetation type by the end of the century. Long-term equilibrium changes are considerably larger. Hotspots of change are, for example, arctic and alpine ecosystems, where trees replace the original herbaceous or shrub vegetation, and the transition zone between temperate broad-leaved and boreal conifer forest. In southern Europe, the projections indicate that large-scale forest dieback might occur as a result of drought. In areas with large vegetation changes, it will be necessary to redefine current management and conservation aims and nearly all species will be affected. When the habitat preferences of individual species in relation to vegetation types are known, the simulated vegetation types can also be used as an additional variable constraining species distributions in species distribution models.

In the second study, we compared different methods for estimating water availability in species distribution models with the soil water content predicted by LPJ-GUESS, which accounts for changes in vegetation structure and functioning including potential effects of increasing CO_2. All water proxies show similar patterns of water availability across Europe for current climate, but when projected into the future, the changes in the simpler water availability measures typically used in species distribution models show no correlation with those projected by the more complex ecosystem model. We conclude that results from envelope model studies concerning future changes in species range shifts should be interpreted with caution and that more process-based representations of the water balance of terrestrial ecosystems should be considered within these models.Further aspects of habitat quality with relevance for most species could be extracted from process-based vegetation or ecosystem models. Simulated levels of disturbance, for example, might influence how vulnerable ecosystems are to invasions. Parameterizing process-based models for large numbers of species, however, is not realistic. We suggest that a functional type approach, as commonly used in generalized vegetation models, might be a more promising approach.

Combining field data and mechanistic modelling to explain community functioning of neotropical small mammals

Tamara Münkemüller (1), Renata Pardini (2), Björn Reineking (3), Thomas Müller (4), Karin Johst (1)
(1) Helmholtz Centre for Environmental Research – UFZ, Department of Ecological Modelling, Permoserstr. 15, 04301 Leipzig, Germany and ETH Zurich, Switzerland
(2) University of Sao Paulo, Institute of Bioscience, Department of Zoology, Rua Matao Travessa 14,101, 05508900 Brazil
(3) University of Bayreuth, Institute of Biogeographical Modelling
(4) Smithonian National Zoological Park and University of Maryland, College Park, MD 20742, USA

There is an increasing recognition that interspecific interactions play a key role in determining the response of species' communities to anthropogenic landscape fragmentation. Interactions of species competing for similar limiting resources can operate via neutral and niche-based processes to promote coexistence. Here, we investigated the relevance of these two broad classes of coexistence processes for the functioning of a small mammal community in the remnants of the Brazilian Atlantic rainforest.

Considering interspecific interactions, disturbances and dispersal, we built a mechanistic simulation model to calculate population dynamics of the eighteen most abundant species in the community (Fig. 1). We estimated lower-level process parameters in the model using large scale field data and recent advances in Bayesian statistics. Parameter estimates highlighted the importance of interspecific interactions for the small mammal community dynamics. Niche-based processes dominated interactions of species using different levels of vertical forest structure whereas neutral processes dominated interactions of species sharing a common level of vertical stratification. The analyses of the diversity patterns on local and regional scales supported this finding. Based on this increased understanding of community dynamics we were able to investigate broad-scale and long-term effects of the current fragmentation pattern and found that it implies a future increase in heterogeneity of biodiversity for the small mammal community.

We suggest the here presented combined approach of Bayesian statistics and mechanistic modeling as a convenient framework for determining interspecific interaction strengths and thus for differentiating between neutral versus niche-based mechanisms of coexistence.

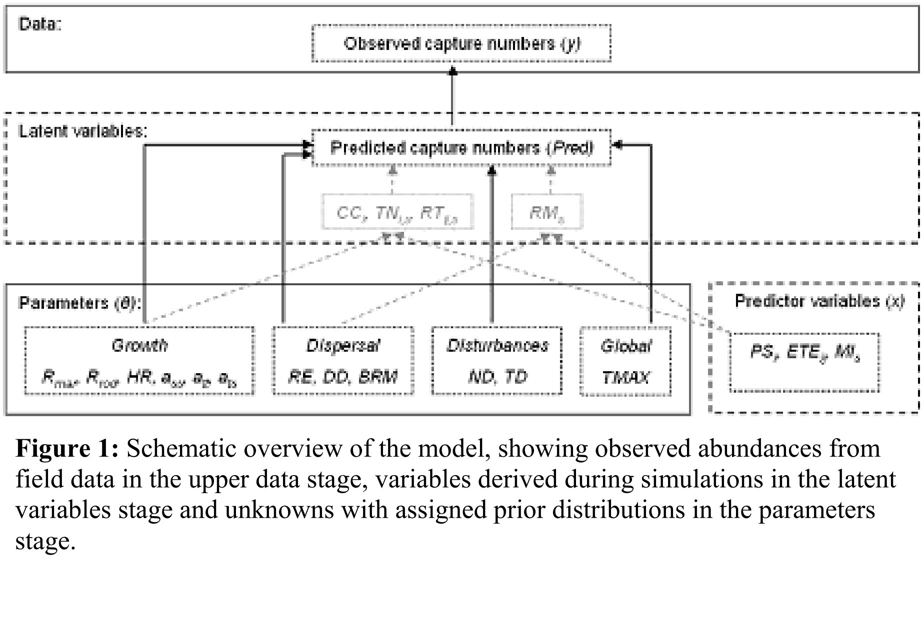

Figure 1: Schematic overview of the model, showing observed abundances from field data in the upper data stage, variables derived during simulations in the latent variables stage and unknowns with assigned prior distributions in the parameters stage.

Forecasting species range shifts: a Hierarchical Bayesian framework for estimating process-based models of range dynamics

Jörn Pagel & Frank Schurr
University of Potsdam, Plant Ecology and Nature Conservation; Maulbeeralle 2, 14469 Potsdam, Germany

Shifts of species ranges have been widely observed as 'fingerprints' of climate change and more drastic shifts are expected in the coming decades. Current studies projecting range shifts in response to climate change are predominantly based on phenomenological models of potential climate space (climate envelope models). These models assume that species distributions are at equilibrium with climate, both at present and in the future. A more reliable projection of range dynamics under environmental change requires process-based models that can be fitted to distribution data and that permit a more comprehensive assessment of forecast uncertainties [1]. To achieve this goal, we develop a Hierarchical Bayesian framework [2] that utilizes models of local population dynamics and regional dispersal to link data on species distribution and abundance to explanatory environmental variables.

In a simulation study we investigate the performance of this approach in relation to the biological characteristics of the target species and the quantity and quality of available biological information. To this end, we generate dynamics of 'virtual species' (a grid-based ecological simulation model), which a 'virtual ecologist' observes using different sampling designs. This virtual ecologist then applies Markov chain Monte Carlo techniques to sample from the full posterior distribution of the model parameters to forecast the future geographical distributions and abundances of the species under prescribed climatic changes. We assess the quality of these forecasts for a range of scenarios varying in both the ecological dynamics and the data used for model estimation. This allows us to identify the potential application range of the presented method and to formulate specific demands for the monitoring of biodiversity responses to environmental change.

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Poster presentations

The role of speciation, extinction and migration in a process-based modeling approach of plant diversity

Kristin Bohn & Axel Kleidon

Evolutionary and historical processes play an important role in understanding how patterns of species diversity change through time [1]. Since the physical environment is a major driver that shapes the growing conditions of plants, changes in climatic conditions force species to adapt to these and thus alters species composition and biodiversity patterns. This happens on longer time scales by processes such as extinction, speciation and migration.

Here we present a process-based dynamic model adapted from the individual global plant diversity model of Kleidon and Mooney 2000 [2], in order to investigate the influence of extinction, speciation and migration of functional plant species on global diversity patterns. The approach of Kleidon & Mooney models global functional diversity by relating physiological processes of functional plants to climatic constraints in a process-based model. The actual model development includes extensions such as considering populations of species instead of individuals, competition for space, extinction, speciation and migration. Since competition results in extinction (competitive exclusion principle), speciation is included to built up new species which will spread out by migration in the model. The rank-size and distribution of a species in the model results from the dynamics of interspecific competition, seed production and dispersal.

The model incorporates extinction, migration and speciation in order to understand how vegetation modifies in changing environments and how diversity patterns will be affected. Here we firstly present the model and will compare the resulting evenness of diversity with the former approach of Kleidon & Mooney.

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Abstract can´t be re-formatted

Natural history data for species distribution modelling: the effects of georeferencing error on model success

Heather Cole and Ariel Bergamini
Swiss Federal Research Institute WSL, Biodiversity & Conservation Biology, Zürcherstrasse 111, CH-8903 Birmensdorf, Switzerland
corresponding author: heather.cole@wsl.ch

Species distribution modelling (SDM) is becoming an increasingly important tool for a variety of purposes. In addition to predicting the potential distribution of species, they are being used to investigate centers of biodiversity, the spread of invasive species, and to predict the effects of climate change on distributions.

Natural history data can be an important data source for SDM, however, with older records this type of data often lacks precise locational information. With the extensive number of natural history records available for the flora of Switzerland, it is essential to determine their value for SDM; to use these data for modelling we have to know what the effects of georeferencing error are on model success. If a certain level of error can be identified as having significant or insignificant effects on the performance of a species distribution model, then the appropriate records can be included (or excluded) from future species modelling endeavours.

To investigate the effects of georeferencing error on model success, several levels of error will be artificially added to existing, precisely located systematic presence-absence (PA) data. We use PA data, because they allow us to start with ecologically and spatially unbiased data. Effects of error on model success may also depend on topographical characteristics of the distribution region (Alps vs. lowlands), on the species group (bryophytes; epiphytic lichens; fungi; non-woody vascular plants), on niche widths of the considered species (specialist vs. generalist), and on the modelling techniques used (e.g. maximum entropy vs. generalized linear model). The results of these factors on model success will be investigated.

Here we present the first results of this research.

Predictive performance of species distribution models depends on species traits

Jan Hanspach., *Ingolf Kühn, Sven Pompe & Stefan Klotz*
Helmholtz Centre for Environmental Research, Department of Community Ecology,
Theodor-Lieser-Str. 4, 06120 Halle/Saale, Germany

Predictive species distribution models are standard tools in ecological research. Within recent years such models have been frequently used to estimate possible effects of climate change on species ranges; however uncertainty is inevitable when making temporal or spatial predictions. Prediction errors depend not only on data quality and modelling algorithm, but also on species characteristics, which have been rarely addressed so far.

Here we applied a standard distribution modelling technique (generalized linear models) based on widely used species distribution data (Atlas Florae Europaeae) and climatic parameters. AUC and Kappa as measures of predictive performance were calculated using cross-validation and subsequently correlated with plant species traits from the BiolFlor database. We accounted for the influence of phylogenetic dependence among the species. Species occurring in human disturbed habitats, annuals and plants with the strategy type stress tolerator-ruderal were poorly predicted. Predictions of suchlike species may be less reliable and interpretation demands special care.

Neophytes and climate – adaptation and propagation of Lunularia

Dominik Katterfeldt, Martin Nebel
Staatliches Museum für Naturkunde – Abteilung Botanik, Rosenstein 1, 70191 Stuttgart, Germany

Neophytes can be studied efficiently when they are expanding their area and begin to colonize new habitats thus possibly influencing the environment. Bryophytes are well tested indicators for environmental changes. In this study we investigate the behaviour of Lunularia cruciata, one of the few bryophytic neophytes in the mid-european flora.

Lunularia cruciata belongs to the complex thalloid liverworts. Liverworts are the first plants on land, as is suggested by molecular and phylogenetic studies. Airpores on the surface and airchambers underneath are functionally convergent to stomata of higher plants. Another characteristic feature are the halfmoon shaped gemma cups which stand for an elaborate dispersal strategy. Originally growing in the Mediterranean and oceanic region, Lunularia cruciata is quite frost-sensitive. In Germany it is to be found mostly along rivers, especially following waste water treatment plants, which supply nutrients for the nitrophilous plant.

First only known impermanently outside greenhouses since 1827, this rather easily recognizable species was rather unattended for a long time. But now it has been spreading since almost 30 years outdoors now, with an increasing rate biased towards today. Just recently male plants have appeared as well which is curious since usually only sterile plants occur at the edges of the area.

Our hypotheses are that

1) Lunularia is becoming more frostresistent by adapting genetically
2) Lunularia is expanding its habitat from former convenient micro-climates to new habitats due to climate change.

This refers to abundance as well as altitude. Based on an analysis of the past we are developing a statistical model to project the distribution of Lunularia into the Future. This study shall incorporate the species' occurrences, interpolated climate data sets, derived bioclimatic variables and yet to be chosen data (i.g. nitrogen deposition).

We consider conveying a population study on genetic level in addition to our findings.

Potential impacts of climate change on the distributions and diversity patterns of European mammals

Irina Levinsky (1), Flemming Skov (2), Jens-Christian Svenning (3) & Carsten Rahbek (1)
(1) Department of Biology, University of Copenhagen, Copenhagen, Denmark
(2) Department of Wildlife Ecology and Biodiversity, National Environmental Research Institute, University of Aarhus, Denmark
(3) Department of Biological Sciences, University of Aarhus, Denmark

The Intergovernmental Panel on Climate Change (IPCC) predicts an increase in global temperatures of between 1.4ºC and 5.8ºC during the 21st century, as a result of elevated CO_2 levels.

Using bioclimatic envelope models, we evaluate the potential impact of these climatic changes on the distributions and species richness of 111 native terrestrial nonvolant European mammals under two of IPCC's future climatic scenarios. Assuming unlimited and no migration, respectively, our model predicts that 1% or 5–9% of European mammals risk extinction, while 32–46% or 70–78% may be severely threatened (lose > 30% of their current distribution) under the two scenarios. Under the no migration assumption endemic species are predicted to be strongly negatively affected by future climatic changes, while widely distributed species would be more mildly affected. Finally, potential mammalian species richness is predicted to become dramatically reduced in the Mediterranean region but increase towards the northeast and for higher elevations.

Bioclimatic envelope models do not account for non-climatic factors such as land-use, biotic interactions, human interference, dispersal or history, and our results should therefore be seen as first approximations of the potential magnitude of future climatic changes. Nonetheless, this study emphasises the potential severity of the impact of climate change on European mammals, especially for the endemic species, which should be taken into account in conservation planning.

Vascular Plant species richness of neophytes, archaeophytes and native taxa on the landscape scale in Switzerland – what's the difference?

Michael P. Nobis (1), Hiltrud Brose (1) & Stefan Birrer (2)
(1) Swiss Federal Research Institute WSL, Zürcherstrasse 111, 8903 Birmensdorf, Switzerland
(2) BDM Coordination Office, c/o Hintermann & Weber AG, Austrasse 2a, 4153 Reinach, Switzerland

In Europe, in addition to differentiating between native and non-native plant species the latter are usually further classified into archaeophytes and neophytes, depending on the date of their arrival before or after the discovery of America. Neophytes and archaeophytes are often treated as separated groups and by many, they are considered to have quite different perceived values and functions in ecosystems.

Here we compare patterns of vascular plant species richness for neophytes, archaeophytes and native taxa on a landscape scale in Switzerland using data from the Swiss Biodiversity Monitoring (BDM; www.biodiversitymonitoring.ch; systematic samples of transect data per 1 km2, N = 486 square kilometres).

Generalized linear models (GLM) were used to correlate species richness with a set of variables including topography, climate, geology, bodies of water and land cover. Of these we found elevation, forest cover and urban land use to be the most important ones to predict species richness of non-natives. Species-richness maps of Switzerland were predicted for all three groups using the GLMs found.

Both, the modelling results and univariate plots show, that along an elevational gradient, neophytes and archaeophytes are most species rich in the lowland. Archaeophytes are more speciose than neophytes in all elevations and diminish more slowly towards higher elevations. In contrast, native species richness is highest in middle elevations. Along a gradient of increasing urban land use, native species richness decreases, whereas species numbers of both neophytes and archaeophytes increase. In contrast, along a gradient of increasing forest cover species richness of non-natives decreases, while natives become more speciose.

Despite their different histories and perceived values neophytes and archaeophytes show quite similar species richness patterns, which are significantly different to native species. As the distributions of neophytes spread and with changing land use and climate, the similarities between neophytes and archaeophytes support the idea that their patterns of species richness may also coincide in the future

Exploring patterns of functional diversity in African termites

Ordonez, A.
Community and Conservation Ecology Group, University of Groningen, Groningen, The Netherlands.

Termites can be considered in general a tropical taxon, their occurrence extending from subtropical to tropical latitudes. In these regions they play a major role as ecosystem engineers, by modifying the interactions between plants, animals and microbial components of the soil biota and by changing the physical properties of soils (e.g. structural heterogeneity, stability, distribution of organic matter, water infiltration and retention). The pattern of termite diversity in the tropics is characterized by a decrease in diversity from the equator towards the poles. This decrease takes place at a slower pace at more southern latitudes. However, no studies have yet assessed whether a similar pattern is present for the distribution of the different functional types (i.e. feeding guilds). The aim of this work was to determine the main factors that shape the distribution of the termites' functional types (e.g. wood ‐ litter, live grass, soil and dung feeders) and assess the hot spots of functional diversity of termites in the African continent. Our results showed that extreme environmental events related to precipitation and temperature are the main divers shaping species distributions, and therefore biological and functional diversity. In particular, we found the closed canopy tropical forests in the Ethiopian region, followed by the tropical savannas in the Riff valley to be the functional and biological diversity hotspots in continental Africa.

Changes in a regional flora over 100 years: methodological problems

Sylvie Pecháčková & Jaroslava Nesvadbová,
West-Bohemian Museum, Kopeckého sady 2, 301 00 Pilsen, Czech Republic

Long-term changes in flora composition and structure reflect changes in the environment, especially climate and landscape use. One possible way to assess such shifts is historical ecology, linking historical and recent data.

A reliable and extensive regional flora was published by František Maloch in 1913. Complete list of plants found in 1896–1913 in surroundings of Pilsen (regional centre of West Bohemia, Czech Republic) was presented in 316 pages, including plant localities, habitats and abundance. A large herbarium collection complements this data set.

Ongoing floristic survey of the same region aims to the comparison of recent and historical data sets to answer following questions:

1/ how the species composition of flora has changed over 100 years?

2/ how the natural and semi-natural habitats have changed?

These seemingly simple questions contain complicated relationships. Do individual species occur in analogous habitats recently and in the past? Which species of which plant communities are able to adapt to changing conditions?

Preliminary results show decline or extinction of some common species of open and nutrient-poor stands (e.g. *Corynephorus canescens*, *Helichrysum arenarium*). On the other hand, some rare species are found after 100 years with almost the same frequency. Changes in species diversity obviously depend on the extent of the pressure on the habitat. As some types of habitats are disappearing, we concentrated on 1/ analysis of overall species distribution in the region, 2/ analysis of pine-forests, which are the most stable type of habitat in the region, and 3/ analysis of heathlands, formerly common and now threatened with extinction.

Many methodological problems arose:

1/ different historical and recent nomenclature of plant species

2/ historical names of localities, nowadays not used

3/ imprecise localization of historical sampling sites

4/ many localities destroyed or habitats changed

We discuss these problems connected with exploration of historical botanical data sets. How to separate influences of the climatic shifts from the land-use changes on the plants seems to be the major question. We want to contribute to the general discussion on what the historical ecology can offer.

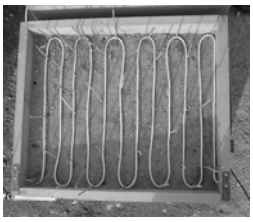
Germination and early growth of *Pinus sylvestris* under different climate scenarios

Sarah Richter [(1)1], Barbara Moser [(1)], Jaboury Ghazoul [(2)] & Tom Wohlgemuth [(1)]
[(1)] Swiss Federal Institute of Forest, Snow and Landscape Research WSL, Zürcherstrasse 111, 8903 Birmensdorf/Zürich, Switzerland
[(2)] ETH Zürich, Institute of Terrestrial Ecosystems, Ecosystem Management, Universitaetsstrasse 16, 8092 Zürich, Switzerland

Throughout the last two decades, high mortality of Scots pine (P. sylvestris L.) has been observed in the upper Rhone valley (Valais), one of the warmest and driest regions in Switzerland. Furthermore field studies show sparse tree establishment after a forest fire in the same region in 2003. Both findings indicate that under climate change Scots pine forests in this region might not be persistent in the long term.

Potential stress factors, directly or indirectly limiting tree vitality, include e.g. climatic conditions, pathogens, insects and competition. However, climate is considered to act as the main driving force. Higher mean temperatures and longer drought periods during summer (as predicted by most climate change models) may aggravate conditions for forest growth. On the other hand, warmer spring temperatures can cause early soil warming, extending the vegetation period and thus having a positive effect on tree growth and survival.

Although changing climate conditions affect all life stages of a tree, its most vulnerable life stage is recruitment. In order to test how early stages, i.e. seed germination and early seedling growth, of P. sylvestris L. are influenced by climatic conditions, we designed a common garden experiment, located at the bottom of the upper Rhone valley. The experimental set-up consists of 5 blocks (replicates) containing factorial combinations of 3 soil heating levels and 3 precipitation levels (9 treatments). Automatically operated shelters intercept natural rainfall, and different precipitation levels are simulated by manual irrigation. Soil heating cables 2 cm below ground increase soil temperature by 0 K, 2.5 K and 5 K, respectively. Germination and early seedling growth of two pine species (P. sylvestris, P. nigra) from different provenances (Valais, Switzerland; Sierra Nevada, Spain) are monitored for two years.

Figures 1 & 2: Experimental set-up. Automatic rainshelters cover seed/seedling beds during rainfall (left). Heating cables increase actual soil temperatures by 0 K, 2.5 K and 5 K, respectively (right).

Islands are Particularly Vulnerable to Sea-Level Rise from Climate Change

Florian T. Wetzel , Helmut Beissmann and Dustin J. Penn
[1]*Konrad Lorenz Institute for Ethology, Austrian Academy of Sciences, Savoyenstrasse 1a, A-1160 Vienna, Austria*

Sea-level rise due to climate change will impact the coasts of some regions more than others, and small islands and deltas are expected to be particularly vulnerable to inundation and erosion [1]. To examine this prediction, we assessed the relative vulnerability of continental Africa versus nearby islands (1,935 islands with total area of 33,970 km²) to loss of area, fragmentation, and loss of protected areas, and we found the following: (1) Islands are extremely vulnerable to climate change, and more than the continent (e.g., they will lose 35-45 x more of total area, and depending on the possible sea-level rise, 7-32% of the island area will be lost). (2) The main factors that predict vulnerability from inundation are small island area, low mean elevation, and high variance in elevation. (3) Protected areas on coasts provide a good indicator for ecologically sensitive zones of the ecosystem, and there is a high potential loss for nationally protected areas (16-56% of protected coastal areas) and even a higher loss for international protected areas (25-84% of protected coastal areas) on islands. Our findings provide strong support for suggestions that islands are likely to incur particularly significant impacts from climate change.

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Impact of global change on biodiversity and biogeochemical cycles

1.8. Nitrogen enrichment in terrestrial ecosystems

Carly Stevens, David Gowing

Oral presentations

Phosphorus limitation as a mechanism for species loss in N polluted ecosystems: from grasslands to globe

Gareth K Phoenix
Department of Animal and Plant Sciences, University of Sheffield, Western Bank, Sheffield, UK

The role of P in mediating the impacts of atmospheric N deposition on plant biodiversity may be particularly important in ecosystems where productivity is limited by P rather than N. Further, such a role for P is likely to become increasing important where long-term N deposition leads to N saturation and greater P limitation in ecosystems. In UK calcareous grasslands which are P limited, understanding what regulates species change is particularly important since these grasslands represent some of the UK's most floristically rich ecosystems and have considerable conservation and amenity value. This importance of P supply in regulating N deposition impacts may also apply at the global scale, where future projections of global N deposition predict many of the major increases in deposition rates will occur in regions where P limitation of ecosystems may be more prevalent.

Here, data is presented from long-term (>15 years) experiments that simulate increased N deposition on P-limited calcareous grassland in the UK (Peak District National Park) that have allowed insight into the effects of N deposition on availability of P to plants and the mechanisms by which such effects occur. In these systems, increased atmospheric N deposition can reduce the plant available soil P pool and may therefore exacerbate P limitation to plants. This reduction in P supply may also be exacerbated by reductions in mycorrhizal functioning seen in some plants under increased N loads. Increases in P limitation is seen further in the greater activity of root surface phosphatase enzymes in calcareous grassland plants under increased N deposition and greater soil phosphatase activities - indicating the increased P demand of plants and microbes in the system.

Plant tolerance of increasing P limitation may be one mechanism that regulates species change in P limited calcareous grassland. Furthermore, where such ecosystems have undergone reduced P availability and increased P stress resulting from N deposition, recovery of the system (including floristic diversity) may require recovery of P availability and a return of normal (unpolluted) ratios of available N:P in the soil. These issues are discussed along with possible implications for floristic biodiversity at the global scale as global N emissions continue to rise.

Biodiversity of European grasslands – gradient studies to investigate impacts of atmospheric nitrogen deposition on grasslands

Carly Stevens (1,2), David Gowing (1), Nancy Dise (2)
(1) Department of Biological Sciences, The Open University, Walton Hall, Milton Keynes, MK7 6AA, UK
(2) Department of Environmental & Geographical Sciences Manchester Metropolitan University John Dalton Building Chester Street, Manchester M1 5GD, UK

Experiments have suggested that reactive nitrogen deposition may reduce species richness. However, until recently there was no clear evidence that widespread biodiversity reduction caused by regional air pollution was actually occurring. An extensive field survey across the UK gradient of atmospheric nitrogen deposition showed a dramatic decline in species richness of acid grasslands with increasing atmospheric nitrogen deposition [1, 2]. Changes in soil chemistry were also observed [3]. Combining the results of the gradient study with experimental manipulations allowed us to estimate the timescale of the observed change in species richness.

The BEGIN project (Biodiversity of European Grasslands – the Impact of Atmospheric Nitrogen Deposition) is a collaborative project between The Open University (UK), Manchester Metropolitan University (UK), Bordeaux University (France), Utrecht University (The Netherlands) and The University of Bremen (Germany). It builds on the results collected in the UK survey and previous experimental work to further investigate these changes. In addition to the 68 acid grasslands already surveyed in the UK, the BEGIN project surveyed 80 acid grassland sites throughout the Atlantic biogeographic region of Europe. At each site data were collected on species composition, soil chemistry and plant tissue chemistry.

Initial results of the BEGIN project will be presented, demonstrating declines in acid grassland species richness and changes in composition across the Atlantic Biogeographic zone of Europe, expanding the range of N deposition to levels both above and below that found in the UK. We will also report initial findings for changes in soil chemistry along this N deposition gradient.

[1] Stevens et al. 2004 Impact of nitrogen deposition on the species richness of grasslands. Sceince, 303, 1876-1879.
[2] Stevens et al. 2006 Loss of forb diversity in relation to nitrogen deposition in the UK: regional trends and potential controls. Global Change biology, 12, 1823-1833.
[3] Stevens et al. Regional trends in soil acidification and extractable metals related to present acid deposition rates. Submitted to Environmental Pollution.

Differential effects of oxidised and reduced nitrogen deposition on European grasslands

Edu Dorland (1) and Roland Bobbink (1,2)
(1) Landscape Ecology, Faculty of Science, Utrecht University, The Netherlands
(2) B-WARE Research Centre, Radboud University Nijmegen, The Netherlands

The negative effects of enhanced atmospheric nitrogen (N) deposition on the structure and function of ecosystems are generally appreciated (e.g. [1], [2]). However, the distinction between N forms within deposition, reduced versus oxidised N, has received little research attention. This differentiation is highly important, as the effects of reduced and oxidised N on vegetation and soil processes can be markedly different. Implementation of national and international policies aiming to reduce N emission has been partly successful. As a result of these measures, the emission of oxidised N decreased in many European countries. However, the emission of reduced N has decreased to a lesser extent or even increased, resulting in increased deposition ratios of reduced versus oxidised N. Evidence is accumulating that increased concentrations of soil ammonium are already causing declines in the abundance of several plant species of conservational importance [3]. Therefore, a better understanding of the differential impacts of reduced versus oxidised N deposition is urgently needed.

The current paper will present results of two N-addition studies with differential treatments of reduced and oxidised N. The first study has been carried out in a diverse rich fen in Ireland and investigated the long-term effects of the addition of reduced and/or oxidised N on species composition and biomass production of bryophytes and higher plants.

Also, some preliminary results of the N-addition experiments carried out within the ESF-funded BEGIN-project will be presented. Acidic grasslands in Norway, Wales and France have been subjected to three levels of N addition, the highest of which also in either reduced or oxidised form. The aim of this study is to investigate the mechanisms of plant diversity reduction due to N enrichment. In addition, the importance of the N form and the possible mitigation effects with more frequent biomass removal via cutting will be quantified.

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[2] Bobbink, R., Hornung, M. & Roelofs, J.G.M. (1998). Essay review: The effects of airborne nitrogen pollutants on species diversity in natural and semi-natural vegetation. Journal of Ecology 86, 717-738.
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Effects of nitrogen deposition on species richness and composition in acidic grasslands. A historical comparison.

Cecilia Duprè & Martin Diekmann
University of Bremen, Institute of Ecology and Evolutionary Biology, FB2; Leobener Str., NW2, 28359 Bremen, Germany

Nitrogen deposition has become a large issue of concern in environmental science and policy. The effects of nitrogen deposition on plant species richness and composition have been studied mainly by means of controlled experiments, but hardly been observed directly in the field.

To do this there are two basic approaches: spatial comparisons of the vegetation along deposition gradients, and time series or historical analyses. Here we apply the latter method, comparing old and new plots from many different sites sampled over a long time period. The disadvantage of not using permanent plot data (from a few sites only) is compensated for by the large number of plots available for the analysis.

In our study we focus on semi-natural acidic grasslands conforming to the community type Violion caninae. In total 1.114 sample plots were compiled, spanning a period of more than 70 years from 1936 to 2007, and sites in five European countries: Great Britain, The Netherlands, Germany, Denmark and Sweden. Environmental plot information included: geographical location (longitude, latitude, and altitude), surrogates for soil (climatic) data based on the mean Ellenberg species indicator values (for moisture, pH, light), plot size, and, for the first time, an estimate of the value of total accumulated nitrogen deposition over time, calculated for the different sites based on present-day modelling data. Multivariate and multiple regression analyses were conducted for data sub-sets from Germany, Great Britain, and the Netherlands.

Results of the ordination show a clear separation of plots sampled during different decades, reflecting directional temporal changes in plant species composition. The sample plot scores were also strongly related to gradients in soil pH and nitrogen. The regressions of environmental parameters on species richness revealed, among others, that the number of vascular plants increased with increasing soil pH and decreased with increasing accumulated nitrogen deposition. This decline in species richness was attributed to a decrease in the number forbs, while grasses did not generally decrease in number (and, hence, increased in proportion to other life forms).

Nitrogen enrichment modifies plant community structure via changes to plant-soil feedback

Manning, P (1), Morrison, S.A (2), Bonkowski, M (3) & Bardgett, R.D (4).
(1) N atural Environment Research Council Centre for Population Biology, Department of Biological Sciences, Imperial College London, Silwood Park Campus, Ascot, SL5 7PY, UK
(2) Faculty of Life Sciences, University of Manchester, Oxford Road, Manchester, M13 9PT. UK
(3) Institute of Zoology, University of Cologne, Weyertal 119, D- 50931 Köln, Germany
(4) Institute of Environmental and Natural Sciences, Soil and Ecosystem Ecology Laboratory, Lancaster University, Lancaster, LA1 4YQ, UK

We tested the hypothesis that nitrogen (N) enrichment modifies plant-soil feedback relationships, resulting in changes to plant community composition. This was done in a two phase glasshouse experiment. In the first phase, we grew eight annual plant species in monoculture at two levels of N addition. Plants were harvested at senescence and the effect of each species on a range of soil properties was measured. In the second phase, the eight plant species were grown in multi-species mixtures in the eight soils conditioned by the species in the first phase, at both levels of N addition. At senescence, species performance was measured as aboveground biomass.

We found that in the first phase, plant species identity strongly influenced several soil properties, including microbial and protist biomass, soil moisture content and the availability of several soil nutrients. Species effects on the soil were mostly independent of N addition and several were strongly correlated with plant biomass. In the second phase, both the performance of individual species and overall community structure were influenced by the interacting effects of the species identity of the previous soil occupant and the rate of N addition. This indicates that N enrichment modified plant-soil feedback. The performance of two species correlated with differences in soil N availability that were generated by the species formerly occupying the soil. However, negative feedback (poorer performance on the soil of conspecifics relative to that of heterospecifics) was only observed for one species.

In conclusion, we provide evidence that N enrichment modifies plant-soil feedback relationships and that these modifications may affect plant community composition. Field testing and further investigations into which mechanisms dominate feedback are required before we fully understand how and when feedback processes determine plant community responses to N enrichment.

Consequences of the experimental nitrogen enrichment to an alpine grassland ecosystem

Ľuboš Halada (1), Wiliam D. Bowman (2), Jana Sedláková (1), Stanislav David (1), Andrej Halabuk (1), Peter Gajdoš (1), Juraj Hreško (1), František Petrovič (3), František Kohút (1), Matej Mojses (1), GabrielBugár (3)
(1) Institute of Landscape Ecology SAS, branch Nitra, Akademická 2, 949 01 Nitra, Slovakia
(2) Mountain Research Station, Institute of Arctic and Alpine Research and Department of Ecology and Evolutionary Biology, University of Colorado, Boulder, CO 80309-0450, USA.
(3) Constantinus PhilosopherUniversity, Department of Ecology and Environment, A. Hlinku 1, 949 74 Nitra, Slovakia

The nitrogen (N) deposition represents currently one of major threats to biodiversity and ecosystem functioning. The increased N input has been associated with a variety of ecological changes in natural and managed ecosystems, including both increases and decreases in species diversity and primary production, loss of base cations, and increases in soil acidity and aluminum (Al3+) concentrations [e.g. 1]. Our experiment consists of 3 nitrogen treatments (20, 60, and 150 Kg N ha-1 yr-1), a phosphorus treatment (50 Kg P ha-1 yr-1) and a control treatment, each treatment replicated 5 times = 25 plots in total. The experimental plots were established in the acid alpine grassland of the alliance Juncon trifidi in Mt. Salatin (Western Tatra Mts, Slovakia, altitude 1900 m) in May 2002. The structure of plant and epigeic invertebrates communities, biomass production, soil, water and plant chemistry were studied.

We did not record decrease of species richness in the plant community (usual response to increased N input) probably due to very acid soil (pH= 3,0-3,8) and previous selection of tolerant species by long-term (50 years) deposition of N. However, in 2007 we recorded decline in abundance of lichen species Cetratia islandica and increased abundance of Festuca supina.

Increased N inputs lowered growth of vascular plants, lichens and mosses; we recorded significant decrease of aboveground plant biomass especially in N150. We believe decreased plant growth with increased N inputs was associated with loss of extractable base cations essential to plant growth, in combination with toxicity of Al and Fe. Extractable base cations decreased by 46% for Ca, 37% for Mg, and 38% for K at the highest input of inorganic N [2].

The increases in N deposition lead also to atypical losses in pools of extractable aluminum (Al3+), while soil acidity and extractable iron (Fe3+) concentrations increase [2]. We suggest that this site and others in central Europe have reached a transition stage in which Fe will dominate buffering of soils. Although hypothesized by Ulrich [3], the buffering stage beyond Al, toward Fe buffering of soils, has not been described in association with atmospheric deposition.

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Soil and plant $\delta^{15}N$ values reveal ecosystem nitrogen dynamics and indicate NO_3 to NH_4 preference of different plant species

Ansgar Kahmen (1), Wolfgang Wanek (2) & Nina Buchmann (3)
(1) University of California, Berkeley
(2) University of Vienna
(3) ETH Zurich

High loads of nitrogen (N) deposition have now been observed for several decades across many terrestrial ecosystems around the world. Interestingly, the consequences of the increasing levels of N deposition for the structure and biogeochemical function of terrestrial ecosystems are still poorly understood. Partly this is because ecosystem N dynamics are highly complex and dynamic processes and simple tools that allow large-scale integrative assessments of ecosystem N dynamics don't exist. In this context, the natural abundance of stable ^{15}N isotopes in plant and soils is potentially a simple tool to assess ecosystem N dynamics. Variability in plant and soil $d^{15}N$ values derives primarily from physiological and biogeochemical processes in the N cycle that discriminate against ^{15}N. Soil processes such as N mineralization, nitrification, denitrification or NH_3 volatilization discriminate against ^{15}N and lead to soil N pools with different $d^{15}N$ signatures. The $d^{15}N$ signatures of different soils N pools are further imprinted in the $d^{15}N$ values of plants that utilize these soil N pools for their N nutrition. Based on the link between foliar and soil $d^{15}N$ signals, foliar $d^{15}N$ values have been suggested to function as simple but valuable tools to study ecosystem N dynamics, both as tracers or as integrative signals.

In the study presented here we tested the applicability of plant and soil $d^{15}N$ values to addresses the effects of N dynamics on the structure and function of European semi-natural grassland ecosystems. In particular, we used the natural abundance of ^{15}N isotopes in soils of 18 different grasslands as a simple tool to link soil N cycling with productivity, plant species composition and plant diversity. In addition, we used stable N isotope ratios in plants from the 18 sites as an indicator for differential NO_3 and NH_4 uptake among co-occurring plant species. Bulk soil $d^{15}N$ of the investigated grasslands was positively related to soil N turnover and indicated strong N effects of productivity, species composition and diversity of the investigated grasslands. Leaf $d^{15}N$ values of 22 different non N_2-fixing plant species were also positively related to soil N turnover as well as to soil $d^{15}N$ values across sites. Within a site variability of leaf $d^{15}N$ values, was explained by differences in the species' NO_3 to NH_4 uptake ratios. The observed differences in NO_3 to NH_4 among species were, however, not species specific but depended on site characteristics and abundance of a species when tested across the investigated sites.

Our study shows that N dynamics have a profound effect on the structure and function of the investigated temperate grasslands. In addition, we were able to show that ^{15}N isotopes in plans and soils are simple and valuable indicators of ecosystem N dynamics such as soil N turnover or plant N uptake. In particular for studies on the landscape or continental level, stable N isotope ratios are valuable and simple tools to address the link between N dynamics and the structure and biogeochemical function of ecosystems.

Biogeochemical processes of nutrients (N, P) in riparian structures adjacent to agricultural fields

Carmen Postolache, Carmen Campian, Mihaela Oprina, Sergiu Cristofor, Angheluta Vadineanu
Department of Systems Ecology, University of Bucharest, Splaiul Independentei 91 - 95, 050095, Bucharest

Riparian zones are important buffers of nutrient fluxes of diffuse origin to the stream systems. They are characterized by high rates of nutrient cycling processes. The aim of the study is to evaluate the rates of most important biogeochemical processes controlling the nutrient retention in riparian areas adjacent to agricultural zones, as well as to identify the main factors which influence the intensity of these processes. This is of great interest in terms of landscape management, as agricultural areas are associated with high nutrient fluxes due to mineral fertilizers applied in order to obtain higher vegetal production.

The study was conducted over a two years period of time in two selected riparian ecosystems with different hydrological characteristics and vegetation cover - one was covered by herbaceous vegetation and the other one was forested. In each study site groundwater levels across the riparian zone were monitored from a grid of piezometers. Different temporal dynamics and spatial heterogeneity of water elevation were obtained for the two zones [1], which allowed establishing: a) the groundwater gradients and the preferential flow direction; b) the influence of the streams water to the riparian groundwater. Nitrate, nitrite, ammonia and phosphate inputs and outputs from the riparian zones were monthly determined at every piezometer in order to estimate the effectiveness of the riparian strip to retain inorganic nitrogen (NO_3-N and NH_4-N) and phosphorous (PO_4-P) entering from the agricultural field.

The research focused on most important biogeochemical processes of nitrogen and phosphorous: nitrification, denitrification and nutrients uptake by vegetation. Rates of microbial processes were determined *in situ,* with a monthly frequency, while nutrient content of plant tissues have been analyzed during the growing seasons. Complementary data of soil temperature, organic matter content, water and sand percentage, have been used in data interpretation.

Nitrogen and phosphorous retention rates vary with the type of vegetation, but the most important factors influencing nitrogen retention/elimination are soil texture and hydrological regime. The "hot spot" for all microbial processes in soil is located in the herbaceous site, adjacent to the wetland zone. The active zone for denitrification shifts from wetland to the inner areas in wet periods, being highest at a water content in soil of about 20-30%, and high concentrations of organic matter and inorganic nitrogen. Nitrogen uptake is higher in the forested area, which seems to be more efficient in nutrient retention as compared to the herbaceous site. Residence time for nutrients in plants is longer than one year. Phosphorous retention is significantly higher than nitrogen retention, especially in the forested site.

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Does N-source niche differentiation change during early succession in sandy ecosystems?

Vanessa M. Stahl, Wolfram Beyschlag & Christiane Werner
University of Bielefeld, Dept. of Exp. & Systems Ecology; Universitätsstr.25, 33619 Bielefeld, Germany

Open sandy grasslands are nitrogen limited habitats where plants are exposed to extreme seasonal climatic variations, particularly to incipient drought. These ecosystems are increasingly endangered because of environmental and land use changes like enhanced atmospheric nutrient deposition which accelerates successional processes. Former works indicated that niche differentiation with respect to spatial, temporal and chemical N-uptake pattern occur in grasslands [1, 2]. So far there is a general lack of knowledge about these processes and their temporal dynamics throughout succession. In order to better understand ecosystem functioning, competition, co-existence and biodiversity in dry grasslands, we investigated species differences in nitrogen source partitioning under natural conditions using $^{15}NO_3^-$-, $^{15}NH_4^+$- and ^{15}N-^{13}C-Glycine labelling. We aimed to determine, if these mechanism are involved in the disappearance of early species during succession and if they impact on biodiversity.

First, we tested if N-source utilization changes during succession from the most available nitrogen source, NO_3^-, to less available NH_4^+, as a strategy for species coexistance with increasing competitive pressure. Second, we compared two typical sand dune species with different growth strategies - *Corynephorus canescens* and *Rumex acetosella*. The former is a pioneer species characteristic for open sand areas, e.g. after disturbance, whereas the latter colonizes later successional stages. We hypothesised that *C. canescens* is a poor competitor and has lower benefits from N-increase than *R. acetosella*.

We tested our hypotheses in three different successional stages with increasing soil nitrogen content: An early pioneer stage, a cryptogam stage and a later successional stage. Our results show significant differences in N-source utilisation of *R. acetosella* and *C. canescens* between these successional stages. Both species can increase their Nitrogen-uptake with ongoing succession and are also able to utilize ammonium as a secondary nutrient-source. Furthermore, it became apparent that C. *canescens* is able to switch between nitrogen niches in contrast to *R. acetosella*. Also a seasonal shift in N-uptake within the successional stages was observed.

Contrary to our hypothesis we showed that *C. canescens* is not a weaker competitor for N than *R. acetosella*, since it increased nitrogen uptake in spite of higher competition.

This study contributes to a process-based understanding of the role of nitrogen enrichment for competition effects on succession in dry grasslands.

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Effects of N availability and lithology on soil bacterial community structure of *Abies pinsapo* forests

Patricia Torres-Cañabate (1), Roberto García-Ruiz (1), Jose Antonio Carreira (1), Mª Belén Hinojosa (2) & Tim Daniell (2)
(1) University of Jaén, Departamento de Biología Animal, Biología Vegetal y Ecología. Campus Las Lagunillas s/n. CP: 2307. Jaén, Spain
(2) Scottish Crop Research Institute (SCRI). Invergowrie, Dundee, DD2 5DA,Scotland, UK

Abies pinsapo-fir forests ecosystems, endemic to coastal mountain ranges in Southern Spain, are remnants of temperate-like coniferous forests that are currently subjected to Mediterranean-type climate seasonality. Stands differ in soil N availability and lithology (serpentine and limestone). We aimed to analyse the effects of both sources of variation in the composition of soil bacterial communities in these forests. We selected two serpentine and two limestone stands differing in N soil availability. Soil eubacterial community structure and diversity were compared in two seasons (spring and summer) in the soil and litter layers, among the four stands of study using terminal restriction fragment length polymorphism (T-RFLP) analysis of 16S rRNA genes. When using T-RFLP tools, together with Principal Component Analysis (PCA), soil and litter bacterial communities were clearly separated according to soil N availability and lithology. In addition, we found significant correlation between the scores of the first two components of the PCA and functional indicators (basal respiration and potential denitrification rates), soil N content and bacterial diversity indices. A relatively low proportion of the observed OTUs (Operational Taxonomic Units) explained a high proportion (> 50 %) of the variance of the two first PCA factors suggesting that a limited range of OTUs drive the observed shifts in community structure in these forests and suggest that soil bacterial community structure may be slightly more influenced by soil N availability than by lithology in *Abies pinsapo* fir forests.

Estimation of nitrogen deposition rates on a regional level using nitrogen concentrations of the epiphytic lichen *Xanthoria parietina*

Stefanie H. Boltersdorf und Willy Werner
University of Trier, Department Geobotany, Behringstraße 21, 54286 Trier, Germany

Epiphytic lichens have been proven to be important bioindicators of air pollution. Compared to physical-chemical methods, they integratively indicate long-term effects of deposition on biological patterns and processes. In the present study, we tested whether the nitrogen and sulphur concentrations of selected epiphytic lichen species can be used to estimate the deposition rates of these compounds in agricultural areas exhibiting a wide range of nitrogen deposition.

In summer 2006, epiphytic lichens (*Evernia prunastri*, *Hypogymnia physodes*, *Parmelia sulcata* and *Xanthoria parietina*) were sampled from, in total, 19 sites located in Western and Southwestern Germany (Münsterland/North Rhine-Westphalia and Rhineland-Palatinate). The samples were collected within a radius of 3 km around field stations for deposition measurement from trees that met the requirements for bioindication with lichens (VDI directive 3799/1). Along with the lichens, bark samples were taken from the trees.

Xanthoria parietina proved to be different from the other investigated lichens in exhibiting the highest nitrogen and sulphur concentrations. Only in *X. parietina*, we found a significantly positive correlation of the nitrogen concentration with the nitrogen deposition rates of the entire study area. The nitrogen concentrations of *X. parietina* were more closely related to the deposition of total nitrogen and of ammonium than to nitrate deposition. In contrast, the nitrogen and sulphur concentrations of the lichens did not correlate with those of the bark. The study demonstrates that it is possible to estimate the deposition of total nitrogen and of ammonium on the basis of the nitrogen concentration of the epiphytic lichen *Xanthoria parietina*.

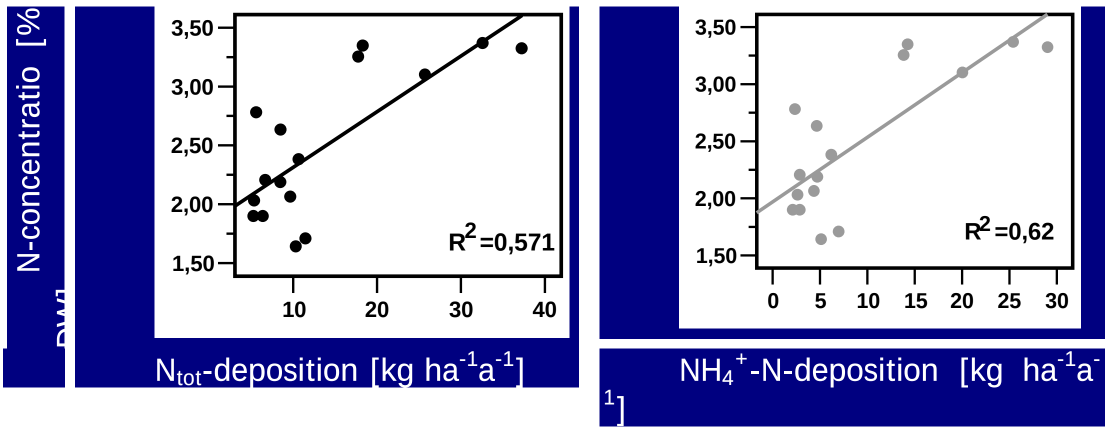

Fig. 1: Correlation N-concentration *X. parietina* / deposition of N_{tot} and NH_4^+-N ((N_{tot}: r=0,756***; n=16; p<0,001/ NH_4^+-N: r=0,788***; n=16; p<0,001).

Poster presentations

Effects of nutrient addition in sand pioneer grassland

Christopher Faust & Christian Storm
Darmstadt University of Technology, Department of Biology/Vegetation Ecology, Schnittspahnstrasse 4, 64287 Darmstadt, Germany

We investigated how a very unproductive plant community (ca. 100 g m^{-2} a^{-1}) responses to nutrient addition in a nutrient poor, calcareous inland sand ecosystem in the upper Rhine valley, Germany. Our focus especially was on primary production, phytodiversity and succession.

Within a five-fold replicated randomized block design, 10 m² plots were given six single or combined applications of nitrogen, phosphorus, potassium and other essential nutrients for four years. An organic carbon treatment was included as a measure to immobilize soil nitrogen. Data were analysed by mixed linear models.

As a result, the above-ground productivity of vascular plant species doubled after nitrogen addition (100 kg ha^{-1} a^{-1}). Additional nutrient elements did not increase productivity further. The cover of the plant functional groups "graminoids" and "herbs" was significantly enhanced by nutrient addition as well as the height of several studied species [Fig. 1]. *Centaurea stoebe* is nitrogen-limited [Fig. 2] and exhibits a decisive impact on total above-ground vascular species productivity. Nutrients did not yet affect phytodiversity. The organic carbon treatment had no significant impact.

We conclude that the productivity of the examined plant community is responsive to nutrient addition. Many species showed nutrient limitation and the total above-ground vascular plant productivity is nitrogen-limited. Succession was accelerated by high-dosage nitrogen addition.

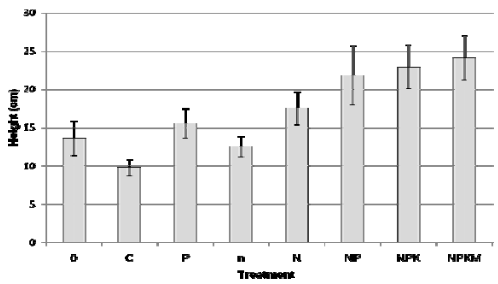

Fig. 1: Mean height of *Silene conica* (cm) in 2005 (n = 5; error bars: mean deviation).

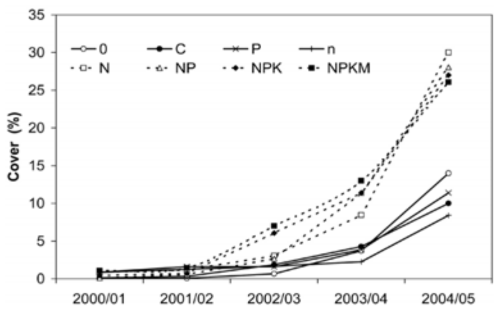

Fig. 2: Mean cover of *Centaurea stoebe* (%) from 2000/2001 to 2004/2005 (n = 5).

Effect of nitrogen depositions on leaching of Ca^{2+}, Mg^{2+} and nitrates from soil of fern stands

(1)Tůma I., (1) Fiala K., (2) Záhora J ., (1) Holub P.
(1) Department of Ecology, Institute of Botany, Academy of Sciences of the Czech Republic, Poříčí 3b, 603 00 Brno, Czech Republic, tuma@brno.cas.cz
(2) Mendel University of Agriculture and Forestry, Zemědělská 1, 61300 Brno, Czech Republic

Improved light conditions, soil acidification and nitrogen (N) availability, support, after destruction of tree canopy, beside perennial grasses, intensive spreading of *Athyrium distentifolium* on deforested sites. Therefore lysimeters with growing fern were installed in order to study the effect of fern on leaching of nutrients from soil. The experimental site was chosen on a southwest–facing slope of the Kněhyně Mt. (49°31′ N, 18° 32′E, 1170 m a. s. l.) in the Moravian-Silesian Beskydy Mts. in the Czech Republic. The area is characterized by an annual mean air temperature of 5.6 °C and annual precipitation of 1110 mm. The field experiment was based on the transfer of soil blocks from partly damaged Norway spruce stand to a deforested site. Sixteen soil blocks (36x53x13 cm, spodo-dystrict cambisols) were dug out in spruce forest without herbaceous cover on April 26 in 2006 and inserted in plastic boxes modified to lysimeters. Lysimeters with planted ferns and with bare forest soil were installed. Each variant was replicated four times. In addition 4 lysimeters with planted ferns and 4 without ferns were treated with 50 kg N in five doses during the growing seasons. Soil percolates were monthly collected and analysed. Values of pH, conductivity and the contents of Ca^{2+}, Mg^{2+}, $N\text{-}NO_3^-$ and $N\text{-}NH_4^+$ in drainage water were determined.

Results of our two year studies indicate that pH values of lysimetric water collected from soil with planted ferns were higher than from lysimeters without planted ferns. Difference between pH of percolates from fern stands and from bare forest soil reached after application of additional nitrogen 1.5 pH on the average. Thus the presence of growing ferns resulted in a decrease of the acidity of lysimetric water. The amount of leached Ca^{2+} from bare forest soil affected by higher input of nitrogen was four to seven times greater then in percolates from lysimeters with planted ferns. The effect of higher doses of N on leaching of Ca^{2+} was obviously minimal on soil with planted ferns. Differences between values of Mg^{2+} content were for both N treatments similar as for Ca^{2+}. Thus, enhanced N input increased the acidity and losses of base cations in unplanted lysimeters. Higher amounts of leached N (above all nitrates) were also recorded here. Published data showed that in stands of fern *A. distentifolium* a great amount of N is accumulated (3.9-7.0 g m^{-2}) at 194-350 g m^{-2} of aboveground biomass [1]. Therefore fern growing in lysimeters may bound a great part of added N in their biomass and partly eliminate soil acidification and leaching of basic cations, similarly as it was assessed in percolates collected from lysimeters with growing grasses [2].

[1] Tůma, I., Fiala, K., Holub, P., Pande, K. 2006: Biomass formation, nutrient upake and release in fern stands of *Athyrium distentifolium* on deforested areas affected by pollution: comparison with grass stands. Ekológia, Bratislava, 25: 264-279.
[2] Fiala, K., Tůma, I., Holub, P., Jandák, J. 2005: The role of *Calamagrostis* communities in preventing soil acidification and base cations losses in a deforested mountain area affected by acid deposition. Plant Soil, 268: 35-49.

Impact of global change on biodiversity and biogeochemical cycles

1.9. Spatial subsidies – Ecological linkages across ecosystem boundaries

Achim Paetzold, Stefan Scheu

Oral presentations

Distributional and population responses of generalist riparian arthropod predators to aquatic subsidies

Achim Paetzold
University of Sheffield, Catchment Science Centre, The University of Sheffield, Department of Animal and Plant Sciences, Alfred Denny Building, Western Bank, Sheffield S10 2TN, UK

A number of studies have demonstrated that generalist terrestrial predators are often more abundant and diverse at the stream edge than farther away. These differences highlight the importance of riparian habitats, but it is not clear to what extent they result from differences in environmental conditions in such habitats, or from resource subsidies from the river, both of which change with distance from the stream. Short-term manipulations of aquatic subsidies have demonstrated that the availability of aquatic subsidies can result in a distributional response of riparian predators along the stream edge. However, to understand the population, community, and ecosystem consequences of alterations in the availability of aquatic subsidies, we need to know whether such findings can be "scaled-up" in space and time: are the density and community structure of riparian consumers along streams really determined by differences in the productivity and composition of aquatic insects?

We applied a range of different approaches, including stable isotopes, field manipulations, and large scale comparative studies, to quantify the importance of aquatic-terrestrial subsidies in different river types. In a braided river flood plain, Tagliamento River, Italy, generalist riparian arthropod predators relied substantially on aquatic prey[1]. Short-term subsidy manipulation have demonstrated that riparian arthropods can effectively use spatially and temporally heterogeneous aquatic subsidies by rapid redistribution. In a recent study, we are exploring the long-term consequences of aquatic subsidies on riparian ecosystems, addressing the question: how does the productivity, and community composition of aquatic insect communities affect the abundance of riparian arthropod predators. Here we use point discharges from abandoned coal mines as "long-term subsidy manipulations". Paired comparisons, upstream and downstream of the mine discharges, were conducted in small to medium sized streams in the North of England. At all sites, we sampled the aquatic insects in the stream and riparian arthropods. Densities of aquatic insects were dramatically reduced downstream of the mine discharge. The effects of the reduction in aquatic insect flux in the impacted sites on riparian spider densities are discussed. Our findings indicate that human impacts on aquatic systems can have wider consequences for adjacent riparian consumers and food webs.

[1] Paetzold, A., C. J. Schubert, and K. Tockner. 2005. Aquatic-terrestrial linkages along a braided river: Riparian arthropods feeding on aquatic insects. Ecosystems 8:748-759.

Habitat manipulation of Exposed Riverine Sediments (ERS), how does microhabitat, microclimate and food availability influence beetle distributions?

Sarah Henshall, Dr Jon Sadler & Dr David Hannah
School of Geography, Earth and Environmental Sciences, University of Birmingham, Edgbaston, Birmingham, B15 2TT

Exposed riverine sediments (ERS) are frequently inundated areas of relatively un-vegetated, fluvially deposited sediment (sand, silt, gravel and pebble). These habitats provide an important linkage allowing the interaction of aquatic and terrestrial habitats and species. ERS are highly valuable for many rare and specialist invertebrates particularly beetles. Within an area of ERS, beetle species richness tends to be highest along the water's edge. This higher species richness may be linked to (1) the availability of food items in the form of emerging and stranded aquatic invertebrates (2) favourable physical microhabitat and microclimate conditions in terms of temperature and moisture. This piece of research explores the role of microclimate and food availability by creating areas of water's edge habitat in the centre of a gravel bar. Typically these areas are dryer, reach higher temperatures and are devoid of emerging aquatic invertebrate prey. Four 2m x 2m experimental plots were created, one wet plot, one wet-fed plot, one dry-fed plot and one dry plot (control), this was repeated on three separate areas of ERS. Fifty colour marked Bembidion atrocaeruleum were released into each plot. The plots were maintained wet using a capillary pump system, and fed with dried blood worms for 30 days. Data loggers were buried just below the sediment surface to record temperature at 15 minute intervals and spot measurements of surface temperature were taken each day. A hand search was carried out on a quarter of each plot after 7, 14, 21 and 30 days. Preliminary results show that after seven days the wet and wet-fed plots yielded the greatest number of beetles. Perileptus areolatus a species usually found at the waters edge was found on both the wet and wet-fed plots on bar 1 and the wet plot of bar 2. This species was not found on any of the dry or dry-fed plots. These early results indicate the importance of moisture and food availability in determining beetle distributions. To further investigate the role of food availability twelve plots (four on each of the three bars) were located at the water's edge with various barriers to influence prey abundance. The barriers comprised of a 2m mesh front panel and 2m wooden side panels; these were installed at the waters edge and dug 15cm into the sediment. One panel comprised of wooden board to completely exclude stranded prey and emerging aquatic invertebrates, one panel was created using 10mm mesh to act as obstacle for emerging insects but allow stranded prey, one panel used 2mm mesh to exclude larger items of prey and one plot was a control with no barrier. A hand search of each plot was carried out weekly for four weeks, and emergence traps were installed to record numbers of emerging aquatic invertebrates. Results from this investigation are yet to be analysed.

Plant litter from riparian forests as a spatial subsidy to a stream ecosystem

Mark Gessner
Department of Aquatic Ecology, Eawag / ETH, Überlandstrasse 133, 8600 Dübendorf, Switzerland

Subsidies of resources across ecosystem boundaries are a vibrant research area, spurred originally by the endeavour to better delineate the trophic basis of consumers in food-webs. Older than the food-web inspired concept of spatial subsidies is the recognition that overall energy flow in some ecosystems depends on massive inputs of allochthonous (i.e. external) sources of organic matter. This tenet holds a central place, for example, in stream ecosystem theory. Although the subsidy and riparian-dependence concepts for streams are closely related, their linkage is rarely made explicit. In an attempt towards better integration, I will first present data on litter input and short-term physical retention and decomposition to estimate litter standing stocks and turnover in a forest stream. Next I will combine these data with estimates of microbial and detritivore utilization (i.e. consumption and production) to assess the overall transfer of litter carbon and nutrients to the food web. Since variation in riparian litter input is relatively small (< ±20%) and short-term retention at base flow is extremely efficient (i.e. retention within some tens of meters), the fraction of litter exploited by stream food webs is likely to be governed primarily by the interplay between plant litter quality and flow regime, especially by the magnitude and timing of high-discharge events. To quantify these effects, I will use a simple simulation model that describes the current pattern of litter dynamics over an annual cycle. I will then confront these results with outcomes from scenarios based on model-derived and hypothetical assumptions about factors such as temperature, dissolved nutrient concentrations and flow regime to gain insight into changes in resource-subsidy capture by stream consumers that can be expected in the face of global change.

Impact of cormorants on arthropod community structure on their nesting islands

Gundula Kolb,Lenn Jerling & Peter A. Hambäck
Botany department, Stockholm University; SE-10691 Stockholm, Sweden

Fluxes of nutrient, energy and organisms across habitat boarders have a great impact on the dynamic and structure of recipient communities. These effects are apparent in the exchange between marine and terrestrial systems, where local densities of predators and detritivores are typically higher in terrestrial communities close to the shore-line. Nutrients and energy from the ocean enter the terrestrial food web mainly via four routes; (1) shore drift of carrion and detrital algae, (2) windblown sea foam, (3) animals (e.g. seabirds and mammals) which feed in the sea but use land to rest and nest and (4) insects with aquatic larval stages and terrestrial adult stage (e.g. phantom midges, caddis flies).

In the Baltic sea, cormorant populations have greatly increased during recent decades, and they play an important role in the coastal ecosystem as fish consumers and as vectors transporting large amount of nutrients and organic material from the sea to land. This marine-derived nutrient and carbon input is specially pronounced in nesting areas were big amounts of nutrient-rich guano are deposited. Due to the high trophic position of cormorants and the fast mineralization of uric acid in guano to ammonium, seabird guano show a highly enriched $\delta^{15}N$ signature. This isotope enriched guano enter the terrestrial food web via root-up take by plants and the fate of the nitrogen can be trace using stable isotope analysis. The isotope enriched guano also enters marine plants and animals around islands, although the increase in marine organisms is less than on the islands, and return again to the island food webs as adult phantom midges and caddisflies. The contrasting response between organisms can then be used to examine the relative importance marine input and other N-sources in predator diets. The resulting food web can then be used, in combination with observed changes in major prey items, to predict responses in predator densities.

Islands with very high bird densities are expected to show a decreased terrestrial herbivore population but an increased phantom midge's supply, due to lower primer productivity on land and an increased nutrient content of marine algae (the food source of phantom midges). Islands with a lower bird density and high primer productivity on land should show a high terrestrial herbivore density. Diet mixing model analysis has shown that web building spiders feed mainly on marine prey while carabid beetles mainly feed on terrestrial prey. Nabid bugs seemed to switch their diet depending on the prey supply: on non-bird islands they prey mainly on terrestrial arthropods while on cormorant islands they mainly prey on marine arthropods.

High density bird islands should therefore show an increased spider density but a decreased carabid beetle density. Bird islands with lower nest densities are expected to show an increased density of predators which mainly feed on terrestrial prey, like carabid beetles.

Marine-terrestrial subsidies: decomposition processes in the intertidal

Ulf Evert, Martin Zimmer
Christian-Albrechts-Universität zu Kiel, Zoologisches Institut; Am Botanischen Garten 9, 24118 Kiel, Germany

The intertidal ecotone interlinks marine and terrestrial habitats. While some intertidal habitats harbour rich communities of primary producers –e.g., saltmarshes, mangroves, kelp beds– others are characterized by little primary biomass production. The latter depend on the input of allochthonous matter. Sand or cobble beaches, for instance, are fuelled by beach-cast wrack of marine origin that is deposited ashore in tidal cycles. Both the amount and the quality of wrack depend on beach characteristics such as slope, topology and sediment grain size. The detritus of most macro-algae, growing on hard substratum, decomposes quickly, while blades of seagrass, angiosperms that grow submerged on soft sediments, decompose slowly. Thus, decomposition of beach-cast wrack through the joint action of detritivores and microbes may be fast, but slow-decomposing wrack accumulates in drift lines. However, continuous deposition and removal through tidal action renders the drift line in a highly dynamic steady state. By contrast, saltmarshes produce large amounts of angiosperm detritus that either remains in place or is transported through wind and wave action towards the terrestrial fringe of the marsh. Here, terrestrial rather than marine detritivores feed on the detritus that is intermediate between marine macro-algae and terrestrial leaf litter in terms of food quality. Through a comparison of sand/cobble beaches and saltmarshes, we will give a brief overview on the fate and the significance of allochthonous detritus within the intertidal area.

CO_2 enrichment effects on nematode feeding groups under cultivation of sugar beet and winter wheat

Christine Sticht (1), Stefan Schrader (1), Anette Giesemann (2) & Hans Joachim Weigel (1)
(1) Johann Heinrich von Thünen-Institut, Federal Research Institute for Rural Areas, Forestry and Fisheries, Institute of Biodiversity
(2) Institute of Agricultural Climate Research; Bundesallee 50, 38116 Braunschweig, Germany.

Atmospheric CO_2 enrichment effects on abundance and proportion of different feeding groups of nematodes (herbivore, bacterivore, fungivore, omnivore and carnivore) were analysed under sugar beet and winter wheat cultivation in a long-term CO_2 enrichment field experiment (FACE: **F**ree **A**ir **C**O_2 **E**nrichment) at the Federal Research Institute for Rural Areas, Forestry and Fisheries (vTI) in Braunschweig (Germany). Within this experiment atmospheric CO_2 elevation is simulated within an agro-ecosystem using isotopically labelled CO_2. This labelling allowed tracing of the C-transfer from the CO_2 enriched atmosphere to the plant-soil system by means of stable C isotopic signatures ($\delta^{13}C$). The $\delta^{13}C$ values of nematodes using different food sources as well as plant and soil material indicated CO_2 impacts on C-translocation. The studies were carried out at two plant developmental stages to consider seasonal aspects.

Atmospheric CO_2 enrichment resulted in increased nematode abundances at the end of both growing seasons, reflecting a stronger impact under winter wheat ($p < 0.05$) compared to sugar beet ($p < 0.1$) cultivation. The proportion of feeding groups in the community differed between crops and plant growth stages and changed under FACE conditions. Generally, the amount of herbivorous species decreased due to atmospheric CO_2 enrichment. Depending on field crop, this impact differed between plant developmental stages. Nematodes feeding on microorganisms (bacteria and fungi) reflected crop specific CO_2 effects. The proportion of bacterivorous nematodes increased at the end of the sugar beet growing season, but decreased shortly before harvest of winter wheat. The percentage of fungivorous nematodes generally increased under FACE conditions when wheat was cultivated. Under cultivation of sugar beet the proportion of this feeding group only increased during the period of main plant growth.

The $\delta^{13}C$ values of crops significantly increased ($p < 0.05$) from above- to below-ground plant parts. Under FACE conditions, the stable C-isotopic signatures of all plant parts significantly decreased ($p < 0.001$). The $\delta^{13}C$ values of nematodes differed depending on cultivated field crop ($p < 0.001$). CO_2 enrichment effects were feeding group specific, reflecting the strongest impact on omnivore ($p < 0.01$) and herbivore ($p < 0.01$) nematodes, and depended on crop ($p < 0.001$) and plant developmental stage ($p < 0.01$). Impacts of atmospheric CO_2 enrichment on stable C isotopic signatures of nematodes were stronger under sugar beet ($p < 0.001$) compared to winter wheat ($p < 0.05$) cultivation.

The results indicate crop specific below-ground effects due to CO_2 induced changes in the root-derived carbon resources. Changing qualities of food sources in the rhizosphere specifically affect nematodes according to their food preferences.

Posterpresentations

From air to soil: tropospheric ozone affects soil mesofauna in the rhizosphere of field-grown wheat

Stefan Schrader, Jürgen Bender, Christine Sticht & Hans-Joachim Weigel
Johann Heinrich von Thünen-Institute (vTI), Federal Research Institute for Rural Areas, Forestry and Fisheries, Institute of Biodiversity, Bundesallee 50, 38116 Braunschweig, Germany

It is well known that tropospheric ozone levels reduce growth, biomass and yield in many crop species. This negative effect is often associated with reduced partitioning of photosynthates to sink tissues such as roots which would be expected to affect root vigor and the rhizosphere environment. However, little is known about the impact of ozone on below-ground processes. Furthermore, there is no information available on how soil mesofauna in the rhizosphere of ozone-exposed crops is affected.

A 2-year open-top field chamber experiment (2006 and 2007) was conducted to examine the effects of ozone on plant growth and on selected groups of soil mesofauna in field-grown winter wheat (*cv.* Astron). Enchytraeids, collembolans and mites were analysed because they play an important role for the C-turnover in soil food webs and are known to be sensitive to chemical changes in the soil environment. Each year, two ozone treatments were conducted from May through June in four replicate chambers: non-filtered (NF) ambient air as control or NF with additional 50 ppb ozone (NF+) for 8 h day^{-1} (10:00-18:00 h). Soil sampling was performed at three dates according to different crop developmental stages.

Ozone reduced plant growth and biomass in 2006, but had little effect in 2007. Root biomass decreased during plant development in NF+ with the lowest biomass (-20%) observed at the end of anthesis. Generally, the individual density of all three mesofaunal groups decreased in the rhizosphere of winter wheat in the NF+ treatment. This result was significant for mites in both years and for collembolans and enchytraeids in the second year. Furthermore, significant results were found at anthesis and at grain maturity, (sampling dates 2 and 3), respectively, but not during stem elongation (sampling date 1).

In conclusion, elevated tropospheric ozone concentrations seem to deteriorate the nutritional conditions for the analysed mesofaunal groups in the rhizoshere of cereal crops. It can be assumed that such effects will influence the dynamic of decomposition processes and the turnover of nutrients.

Road density in Greek Natura 2000 network

Votsi N. (1), Mazaris A.D. (1), Papadimitriou K. (1), Kallimanis A.S. (2), Sgardelis S.P. (1), Pantis J.D. (1)
(1) Department of Ecology, Aristotle University of Thessaloniki Greece.
(2) Department of Environmental and Natural Resource Management, University of Ioannina, Greece.

Generally protected areas are considered roadless and devoid of human presence. But in Greece, all protected areas are inhabited and crisscrossed by roads characterized by greater or lesser traffic load.

In this study, we estimate the road density in the protected areas of the Greek Natura 2000 network. Furthermore we investigate the magnitude of change in landscape structure caused by these roads in our study areas.

More specifically we study the composition of habitats intersected by roads and compared them to the habitats available in the protected areas. Furthermore, on the landscape level we compared the spatial characteristics (fragmentation, shape …) between sited with different road densities, in order to distinguish the impacts of roads in landscape structure.

Our results showed that human activities (such as agriculture and settlements) are located near the road network. Furthermore, we found that roads with low traffic load have a greater impact on landscape structure of protected areas than the national roads and highways, that systematically avoid intersecting protected areas. Landscape fragmentation differentiated according to the type of road, while road presence seemed to increase the shape complexity of the patches.

Impact of global change on biodiversity and biogeochemical cycles

1.10. Tropical biodiversity and Global Change

Pia Parolin, Marcell Peters, Urs Giesselmann

Oral presentations

Influence of landscape configuration and fragmentation on biodiversity patterns in the Mata Atlantica, Brazil

Christoph Knogge (1) , Jean Paul Metzger (2) & Klaus Henle (1)
(1) UFZ-Helmholtz Centre for Environmental Research; Permoser Str. 15, D-04313 Leipzig, Germany
(2) USP-University of Sao Paulo, Dept. of Ecology, Lab. of Landscape Ecology and Conservation, R. do Matao 14 trav. 321, Sao Paulo, SP Brazil

As in most of the developing countries, the elimination and fragmentation of forested areas are part of the development process in Brazil, which leads to the expansion of agricultural lands and urbanisation, but also to land degradation, loss of ecosystem services and biological extinction. This process is particularly prevalent in the Mata Atlântica a typical biome with the highest overall biological richness in the world and globally ranked as one of the 15 hotspot regions.

Our project intends to analyze which factors determine in fragmented landscapes the diversity patterns, processes and the distribution of bird, mammal and amphibian species. More specifically the project was designed to answer the following detailed questions:

I. What is the relative importance of forest quantity, spatial configuration and cover for the maintenance of the biodiversity in fragmented landscapes?
II. What is the relative importance of the habitat structure in relation to the landscape structure?
III. What are the effects of forest fragmentation and anthropogenic perturbations on forest regeneration?
IV. What is the importance of functional connectivity for the maintenance of species in fragmented landscapes?
V. What is the effect of the history of changes in the landscape structure on the communities?
VI. What is the potential distribution of species representative for the local biota?
VII. Which are the priority areas for conservation at the Atlantic Plateau?

The results of the different taxonomic groups (plants, vertebrates and invertebrates) and ecological processes clearly indicate a species loss and changes in processes in a fragmented landscape. The sensitivity of species to fragmentation is very much related to the dispersal capacities and area requirements. The biological value of a fragment not only depends on its extension but also on the structure of its forest and the degree of connectivity to neighbouring fragments. Conservation efforts should thus consider the context in which a fragment is situated, moving the focus from the fragment onto the landscape. Despite of the species loss of more sensitive species, fragmented landscapes, which are well connected and with habitat cover of 30% still harbour a good part of the biodiversity. For the maintenance of the whole integrity of the community, including the species that are more sensitive to fragmentation, not only extensive forests are necessary but also less disturbed forests where the structure of late/mature forests is maintained. Since the studies that claim 30% forest cover as an typical fragmentation threshold have been conducted in temperate zones, it is not known whether such threshold does exist in tropical ecosystems and if what would be the range of such a threshold. Therefore further landscapes with differing forest cover of 45% and 15% are currently being studied.

Potential of plantations for conservation of forest birds and for tree seedling recruitment

Farwig, Nina (1,2); Sajita, Nixon (3), Böhning-Gaese, Katrin (2,4)
(1) Dep. Sustainable use of natural renewable resources, University of Marburg, Karl-von-Frisch-Str. 8, 35032 Marburg, Germany
(2) Dep. of Ornithology, National Museums of Kenya, Nairobi, Kenya
(3) Kakamega Environmental Educational Programme, P.O. Box 143, Kakamega, Kenya
(4) Dep. Community & Macroecology, University of Mainz, Becherweg 13, 55128 Mainz, Germany

Tree plantations of native and exotic species are frequently used to compensate for forest loss in the tropics. Yet, these plantations may support lower species diversity and different communities than natural forest. To evaluate the potential of differently managed forest types for conservation of forest birds and indigenous seedling recruitment we studied structural characteristics as well as tree, bird and seedling communities in stands of natural forest, different types of tree plantations and secondary forest in Kakamega Forest, western Kenya. Forest types differed considerably in structural characteristics and tree species richness and composition. Accordingly, species richness and composition of the bird communities clearly changed between natural forest and plantations of single tree species. By contrast, seedling species richness did not differ among forest types and seedling communities were placed in closer proximity to each other and tended to be closer to natural forest communities than the respective adult tree communities. These findings demonstrate that natural forest areas are needed for the conservation of forest bird diversity, but that plantations with a mixture of indigenous tree species can have similarly high conservation value. Further, a convergence of monocultures to natural forests may take place but changes in the seedling species composition in the course of succession are also possible.

Decline of Ant-following Birds in African Rainforest Fragments: Patterns and Causes

Marcell K. Peters
Zoologisches Forschungsmuseum A. Koenig, Adenauerallee 160, 53113 Bonn, Germany

In the tropical rainforests of Africa and America specialized insectivorous birds follow the swarm raids of army ants and prey on insects which are flushed by the ants. In a Congo-Guinean rainforest in western Kenya, I studied the consequences of habitat fragmentation on African ant-following birds and analyzed if their response is related to the availability of army ant colonies in habitat fragments. Similar to ant-following birds in the Neotropics most specialized ant-followers totally disappeared or strongly declined in small forest fragments. My data suggests that the decline of these birds is best explained by a decrease in the size of forest fragments and by the loss of *Dorylus wilverthi* army ants from small forest fragments. Even though a second army ant species, *Dorylus molestus*, compensated the decline of *D. wilverthi* in terms of mean abundance it can not functionally compensate it because the daytime activity of the former but not of the latter species is depending on high humidity conditions. Consequently, in the dry season specialized ant-followers in small fragments missing *D. wilverthi* colonies probably suffer from food scarcity due to a cease of army ant foraging. This study elucidates that a subtle alteration of the species composition in fragmented rainforests may have large ecological consequences.

Understanding the impact of human disturbance on tree species community in tropical forest fragments

Pütz, S. (1,2), Alves, L.F. (3), Groeneveld, J. (1,4), Oliveira, A.A. (5), Metzger, J.P. (5) & Huth, A. (1)
(1) UFZ Helmholtz Centre for Environmental Research, Department of Ecological Modelling, Leipzig, Germany
(2) UFZ Helmholtz Centre for Environmental Research, Department of Nature Conservation, Leipzig, Germany
(3) Botanic Museum, Department of Ecology, São Paulo, Brazil
(4) School of Geography, Geology and Environmental Science, University of Auckland, New Zealand
(5) University of Sao Paulo, Department of Ecology, São Paulo, Brazil

Anthropogenic land use in the tropics leads to massive habitat destruction and following habitat fragmentation, e.g. of the Brazilian Atlantic Forest (Mata Atlântica), one of the biodiversity hot spots in the world. However, fragmentation processes acting on structure and dynamics of tropical forest fragments are not the exclusive drivers, selective human disturbances as e.g. firewood extraction may act as factors, too, especially in the vicinity of dense populated urban areas.

Combined impacts of different drivers lead to increasing complexity of influencing factors and thus challenge further understanding of fragmentation effects on tropical tree species communities on the long term. Such challenges can ideally be tackled with simulation models.

We present the first simulation study of tropical forest fragments taking human disturbance into account, aiming to gain an understanding of how tree species in tropical forest fragments react both to fragmentation and human disturbances.

For this analysis we use the individual based spatially explicit forest growth model FORMIND. The simulation model is applied to the Brazilian Atlantic Forest at the study site Caucaia / Ibiuna at the Plateau of São Paulo.

Global change effects on vascular epiphytes

Gerhard Zotz
University of Oldenburg, Institute of Biology and Environmental Sciences; Ammerländer Heerstrasse 114-118, 26129 Oldenburg, Germany

Epiphytes, both vascular and non-vascular, comprise a major portion of tropical plant diversity. In contrast, our understanding of their likely response to on-going anthropogenic changes is rather poor compared to that of co-occurring trees. Based on the available evidence vascular epiphytes have been called particularly vulnerable to climate change because of their existence at the interface of vegetation and atmosphere. I review the basis for this notion and put this analysis in the larger context of human-induced changes in general. Besides climate change, land-use changes adversely affect epiphytes, while other factors, e.g. biotic exchange, are of lesser importance in this life form. Both land-use change and climate change primarily affect hygrophilic taxa, while drought-resistant species may even benefit. Based on field observations, vascular epiphytes in tropical cloud forests will seriously suffer from decreased moisture input. In contrast, varying precipitation in more seasonal lowland forests seems to affect vascular species rather little, but a possible, negative impact of rising temperatures or a compensating positive effect of rising CO_2 concentrations on plant performance are virtually unexplored. Noteworthy, most of our current knowledge stems from *in situ* observations, but for a mechanistic understanding experimental manipulation is necessary.

I present the first results of on-going experiments which study the growth response of vascular epiphytes from lowland and montane forests to varying CO_2 concentrations (350 vs. 750 ppm), temperature, water and nutrient supply under controlled conditions. These experiments are complemented by studying the temperature response of germination. In general, the growth stimulation by increased CO_2 concentration was rather low, irrespective of photosynthetic pathway (CAM vs. C3), while growth was much more affected by water availability. However, increasing nutrient supply beyond *in situ* input levels highly stimulated growth and reduced the effect of both CO_2 and water supply. Moreover, there was considerable interspecific variation impeding easy generalisation. I conclude that the likely response of epiphytic flora to global change can only be evaluated by careful field observations in conjunction with complex experiments with a large suite of species.

Estimating angiosperm distribution patterns in the Neotropics

Sven Lautenbach (1), Carsten F. Dormann (1), Claudia Raedig (2)
(1) UFZ - Helmholtz Centre for Environmental Research, Department for Computational Landscape Ecology, 04318 Leipzig, Germany
(2) Department of Systematic Botany, Institute of Biology, University of Leipzig, 04103 Leipzig, Germany.

Species distribution patterns enable scientists and conservation planners to estimate centers of biodiversity and centers of species confined to very small distribution areas, so-called narrow endemic species. Contrasting distribution patterns with population density and climate change scenarios allows the identification of priority areas for conservation planning. Monographic data offer a rich data source for large-scale species distribution estimations. However, monographic data are subject to a set of drawbacks that need to be considered. We developed an inverse-distance interpolation approach based on the alpha-hull to construct species ranges for approximately 4,000 Neotropical angiosperm species. These were combined to species richness maps and maps of narrow endemic species. The approach corrects for the bias introduced by sampling effort. Further, the robustness of the approach was tested by a leave-on-out cross-validation. The interpolated species richness maps together with species richness maps of narrow endemic species allowed the identification/localization of species richness centers. These centers have been intersected with maps of population scenarios, the World Database on Protected Areas 2007 and maps of climate-induced changes in key ecosystem processes to identify priority areas for conservation planning.

Potential impact of global warming on selected species of neotropical cichlid fish

Uwe Römer (1) & Ingo Hahn (2)
(1) University of Trier, Inst. Biogeography, Dep. Geo-Sciences, Am Wissenschaftspark 25-27, D – 54296 Trier, Germany; e-mail: eu.roemer[at]t-online.de
(2) Institute of Landscape Ecology, Biogeography and Animal Ecology Research Group, Robert-Koch-Straße 28, D – 48149 Münster; Germany; e-mail: ingo.hahn[at]uni-muenster.de

Neotropical fish usually only play a minor role in the debate on ecosystem changes caused by global warming. We will present actual results of our long time research program on "Species diversity of neotropical dwarf cichlids" linked to little known effects of rising temperatures on a large flock of small neotropical cichlid species.

Among small neotropical cichlids, *Apistogramma* today represents the genus with the highest number of known taxa, i.e. about 70 described species as well as roughly 250 forms still awaiting description. Alpha-taxonomy in this rapidly radiating species group is difficult, as recently several cryptic species have been identified by conservative methods, but still could not be confirmed in genetic research. Species of the genus are widespread in all types of flowing and stagnant waters in nearly all parts of the East-Andean tropical and subtropical lowlands making the genus an ideal model for comparative ecological and evolutionary studies [1].

Ecological adaptations of *Apistogramma*-species are overall extreme: They inhabit extremely acid and nutrient poor waters (ph 3.5 / conductivity < 10 µS/cm) as well as basic and nutrient rich waters (ph > 8 / conductivity > 600 µS/cm) with temperatures ranging from 13°C to 36°C [summarized in 1]. Main topic of our recent research was the possible biological response to changes of riverine temperature regimes.

Members of the genus *Apistogramma* were the first group of freshwater fish in which environmental sex determination (ESD) was detected [2]. Differentiation of sex in the offspring of all species investigated (n = 33) is controlled mainly by two combined environmental factors: temperature as the dominating factor, and acidity as co-factor. We will show in which way these two factors are triggering changes in the sex ratio in offspring of *Apistogramma* and the responses of both sexes on skewed sex ratios reflected in their mating systems, social systems, and overall socio-biology on the background of our recent research results [3]. Finally potential effects of rising average temperatures on distribution, speciation and diversity will be discussed.

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Poster presentations

Patterns of functional group diversity in relation to environmental gradients: an example from South Ethiopian highlands.

Desalegn Wana Dalacho & Carl Beierkuhnlein,
Department of Biogeography, University of Bayreuth, D-95440, Bayreuth

Ecologists have long been interested in the relationships between biodiversity and ecosystem functions. The widely used currency of species richness has invariably been equated as biodiversity and hence has been used to investigate the effects of biodiversity on ecosystem functions. Nevertheless, the recent interests to investigate the relationships of plant functional groups diversity and their relative roles in structuring the ecosystem and its functions have attracted much attention. The functional groups, which are identified on the basis of effects or responses traits, can be used as a proxy variable to understand the mechanisms of ecosystem processes and functions [1]. The objectives of this study were to investigate the patterns of functional groups diversity along environmental gradients and explore the underlying causes for such patterns. The study was conducted in the Gughe-Amaro Mountains, southern Ethiopian highlands. A 20 m X 20 m plots were laid following altitudinal gradients and species identities and their functional traits were recorded in the field. Multivariate statistical analyses were carried out by using CANOCO 4.5.

The results showed that different functional groups vary along environmental or disturbance gradients. Succulents and thorny species (traits related to water use efficiency and grazing) were more concentrated on lower slopes, lower altitudes and frost free conditions. Nitrogen fixers, leaf seasonality and annual grasses were correlated with low organic carbon and high stone cover. When the nitrogen fixing groups were subdivided into herbaceous and woody species a slightly different pattern emerged; i.e., herbaceous nitrogen fixers were correlated stronger with available phosphorous in the soil than woody nitrogen fixers. Similarly, rhizomatous and rosettes perennial herbs were correlated strongly to altitude and organic carbon while annual herbs were related to higher slope and silt content of the soil. The close association of nitrogen fixing woody species and leaf seasonality in the lower elevation could be due to a response to conservation and access to much needed resources such as water and nitrogen, respectively. Species diversity and functional group diversity showed positive (R^2= 0.2647) but weak relationships that imply variations in the mechanisms that generate species and functional group diversity.

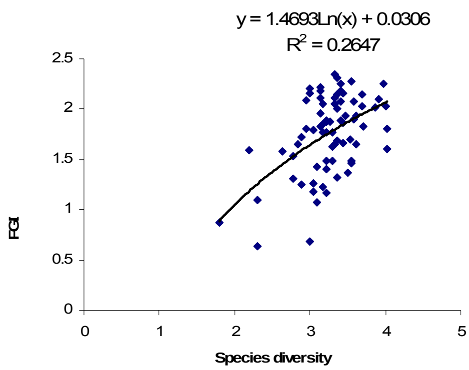

Fig 1. Regression graph of functional and species diversity.

Therefore, it can be concluded that resource conservation (e.g., moisture/water) and traits related to nutrient accessations are important trait responses of vegetation, especially functional groups, along altitudinal gradients.

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Exceptional high epiphyte diversity in the Rio Changuinola valley, Panama

Stefan Laube, Glenda Mendieta & Lars Nauheimer
Carl von Ossietzky Universität, IBU; 26111 Oldenburg, Germany, stefan.laube@uni-oldenburg.de

We studied the diversity of vascular epiphytes in the Rio Changuinola valley, Bocas del Toro Province in Panama, as part of a species assessment project initiated to evaluate impact of the construction of a hydroelectric power plant on biodiversity in this area. Epiphytes are a very conspicuous part of tropical rainforests and contribute to a large extent to biodiversity. However, epiphytes remain a very poorly studied group of organisms, especially on the more remote and harder to access Atlantic slope of the isthmus. With this study we contribute substantially to the knowledge of the biogeography of vascular epiphytes in Central America.

In total we surveyed 25 sites totaling c. 2 hectares of secondary and primary lowland rainforest. We surveyed the study sites for epiphytic plants by means of ground observation and tree climbing techniques and evaluated species richness, composition of species, and abundance.

During the study we encountered the amazingly high number of 479 vascular epiphyte species. This number is the highest reported so far for a lowland rainforest site in the Neotropics, indicating that the region is one of the hot spots of epiphyte diversity. The overall taxonomic distribution of epiphytes found reflects the general global pattern: the Orchidaceae with 181 species found is by far the most diverse family in the area followed by the Araceae (78 spp.), Bromeliaceae (33 spp.), Polypodiaceae (28 spp.), Hymenophyllaceae (25 spp.), and Piperaceae (22 spp.). These five families alone constitute for more than two third of all epiphytic species found while the majority of families are represented by only one to five species.

Extrapolating the number of encountered epiphyte individuals in 800 m² of forest to the complete area that will be directly affected by the construction of the water reservoir we yield a total number of about 14 million epiphytic plants that will be lost due to immediate destruction of the habitat in this area. Among the 479 plant species found are various which are of special scientific and conservational value. Besides more than 180 new reports for the Province of Bocas del Toro, we found 28 species that are new reports for the Republic of Panama. Further, we found 12 endemic species, and probably 4 species completely new to science. Description of one of them, an orchid species, will be published soon.

Land use dynamics and its consequences for biodiversity

2.1. Biodiversity and ecosystem functioning (pollination) in changing landscapes

Ricardo Bommarco, Ingolf Steffan-Dewenter, Catrin Westphal

Oral presentations

Quantifying the ecological value of modified landscapes

Robert M. Ewers (1) and Raphael K. Didham (2)
(1) Imperial College London, Silwood Park Campus, Ascot, Berkshire SL5 7PY, UK
(2) School of Biological Sciences, University of Canterbury, Private Bag 4800, Christchurch, New Zealand

Biodiversity loss and the provision of ecosystem services are not randomly distributed across modified landscapes. Patterns of habitat loss and fragmentation vary from landscape to landscape, further defying attempts to quantify the ecological value of any given region. Here, we use a georeferenced New Zealand dataset of more than 28,000 beetles from over 850 species to investigate how fine-scale spatial patterns of habitat within fragmented landscapes scale up to influence populations, species and communities at the landscape-scale. Habitat edges are a ubiquitous feature of modern landscapes and have a detectable signal on the abundance of individual species and functional groups that penetrates as far as one kilometre inside forest remnants, impacting species richness, beta-diversity and community structure across entire landscapes. Such large-scale edge effects interact with the complex shape of fragments in real landscapes to dramatically reduce the population size of species restricted to forest interiors, and may even lead to their local extinction from isolated habitat fragments and protected areas.

Given that landscape patterns are so variable in space and time, what options are available for quantifying the ecological value of a landscape? We suggest that landscape configuration can be integrated with on-the-ground biodiversity surveys to map spatial variation in the composition of ecological communities. To this end, we present a novel method for generating spatially explicit biodiversity surfaces for present-day and pre-human landscapes, effectively creating a detailed map of ecological change. We show that directly incorporating spatial patterns into indices of biodiversity change can greatly alter our perception of the ecological value of landscapes.

Extinction patterns in plants and species traits in fragmented landscapes

R. Lindborg (1), A. Helm (2), M. Pärtel (2)
(1) Dept. of Systems Ecology, Stockholm University, Sweden,
(2) Inst. of Ecology & Earth Sciences, University of Tartu, Estonia

Fragmentation, isolation and loss of habitats have been recognized as one of the major threats to biodiversity. Several studies have manifested that many species are at an extinction risk due to changes in ecological processes associated to fragmentation [1,2]. The difficulties for species to disperse in fragmented landscapes have been documented through patterns of distribution where a large number of habitats, suitable for a given species, stay unoccupied by this species[3].

One problem, however, when using species richness as a general biodiversity indicator is that species do not respond similarly to isolation and habitat loss [4, 5]. By dividing species based on their life-history traits it is possible to separate species into groups based on their different ecological function [6]. As relationships between traits and ecological functions have been documented it is possible to group traits with similar function and look for trade-off between groups. Two such clear groups among plants are the traits related to species dispersal (such as seed mass, terminal velocity, seed production or seed bank) and traits related to growth and competition (such as plant height, flowering time, or life history strategy) [7,8].

During the last decade several studies have analyzed how plant species react to isolation and different habitat area. In this study we review how different plant life-history traits respond to isolation and habitat area in grassland and woodland ecosystems across Europe. We demonstrate which plant traits are negatively associated to habitat loss and isolation, and conclude which plant groups, based on their life-history traits, are most sensitive to fragmentation or area loss. We discuss how these results can increase the understanding of the overall ecosystem function in plant communities. Based on our analysis, it is possible to identify the plant species that are most vulnerable to changes in landscape structure. This knowledge can be incorporated in long-term management to prevent future extinctions.

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Predicting insect responses to habitat loss and fragmentation from species traits

Erik Öckinger & Riccardo Bommarco,
Department of Ecology, Swedish University of Agricultural Sciences, Uppsala, Sweden

Local species richness is predicted to decrease with decreasing patch area and increasing isolation. In empirical studies, this is not always the case. One reason may be that species respond differently depending on their life-history traits. It has been predicted that traits such as body size, trophic level, mobility, niche breadth and reproductive potential could affect species responses to habitat loss and fragmentation.

Here we use a meta-analysis approach to test the generality of these predictions for two relatively well studied groups of insects, bees and Lepidoptera (butterflies and moths) across a large number of studies and across habitats, landscape types and continents. We collected published (and a few unpublished) studies of species richness of these groups in relation to patch area and isolation. Data on life-history traits was retrieved from published sources (Lepidoptera) and from an unpublished database (bees). In total we got access to data from 24 studies from both Europe and North America on butterflies and moths and from six European studies on bees.

For Lepidoptera, we found that sedentary species and species with narrow larval food niches were more strongly influenced by patch area and isolation. For bees, we expect to find significant effects of body size, feeding niche breadth and trophic level.

If species responses to habitat loss and fragmentation depend on life-history traits, communities in small and isolated patches will not only contain fewer species than large and well-connected ones. They will also differ significantly in community composition, and to a high extent be dominated by mobile generalist species. This may in turn influence important ecological processes such as pollination.

Habitat connectivity affects butterfly diversity and community composition in calcareous grasslands

Sabrina Brückmann, Jochen Krauss, Ingolf Steffan-Dewenter
University of Bayreuth, Animal Ecology I, Population Ecology, Universitätsstrasse 30, 95447 Bayreuth, Germany

Calcareous grasslands are one of the most species-rich habitats that exist in Europe. Abandonment of historic land use practices and intensification of agricultural land use have led to significant habitat loss and fragmentation during the last decades. As a result remaining grassland habitats are often small and isolated patches in a landscape context of different agricultural and forest habitats. Previous studies showed a decline of plant as well as butterfly diversity with grassland area loss. However it is less well known to what extent the surrounding landscape differing in connectivity rates affects species occurrences and population densities in fragmented habitats.

We conducted eight butterfly surveys from April to August 2007 in 62 paired small and large grassland patches within 31 independent landscapes and identified 88 butterfly species including burnets. Plant mapping per site was conducted twice in May and July 2007. The study design allowed us to explore effects of area and connectivity independently from each other.

We hypothesize that butterfly and plant diversity is higher in large compared to small habitats, and higher in landscapes with increasing connectivity. Further, we expected stronger effects of habitat connectivity for specialized compared to generalized butterfly species.

Is time delayed extinction a major threat for grassland butterflies and vascular plants?

Jochen Krauss, Ingolf Steffan-Dewenter
University of Bayreuth, Animal Ecology I, Population Ecology, Universitätsstrasse 30, 95447 Bayreuth, Germany

Time delayed species extinction (often called extinction debt) is a rarely recognised threat for long-term species survival in fragmented habitats. Habitat destruction by abandonment and by agricultural intensification leads to loss of semi-natural grasslands throughout Europe within the last 50 years. These semi-natural grasslands are local diversity hotspots for insects and plants. If we have to expect an extinction debt for many of the specialised species of this habitat type is unclear. In the EU project COCONUT (Understanding effects of land use changes on ecosystems to halt loss of biodiversity, www.coconut-project.net) we recorded vascular plant and butterfly species richness in 30 fragmented semi-natural grassland sites in each of five countries (Estonia, Finland, Germany, Spain, Sweden). Within a 2km buffer around each study site we quantified actual habitat loss using current and historic aerial photographs and calculated possible extinction debts. In total we recorded 924 vascular plant species and 142 butterfly species. Historical habitat loss of semi-natural grasslands ranged from 0 % to almost 100 % depending on site and country. Time delayed extinction depends on species traits and the history of each country. However, a severe reduction in species richness due to extinction debt might still be of importance depending on local and regional historic situations.

Analysis of extinction debt in Mediterranean grasslands in NE Spain

Joan Pino (1), Moisès Guardiola (1), Constantí Stefanescu (2), Ferran Rodà (1)
(1) Center for Ecological Research and Forestry Applications (CREAF) and Unit of Ecology, Autonomous University of Barcelona E-08193 Bellaterra (Spain)
(2) Museu of Granollers of Natural History "La Tela", Francesc Macià, 51 E-08400 Granollers (Spain)

An increasing number of studies have identified transient times of species disappearance in response to habitat loss and fragmentation, resulting in the so-called extinction debt. However, as far as we know, there are no data available for Mediterranean habitats. Within the EU-FP6 COCONUT project, we have analysed the effect of habitat loss on plant and butterfly species richness in Mediterranean seminatural grasslands in Catalonia (NE of Spain). Area and connectivity (i.e. the amount of habitat in a buffer area of 2-km radius) were obtained for 30 grassland patches of variable size and history by digitizing the target habitat on present-day (2006) and past (1956) orthoimages, and the change percentage was calculated for both measures. Vascular plant and butterfly richness per patch were estimated through field sampling proportional to patch area.

We removed from the analysis the patch connectivity variables because they were moderately correlated with patch area measures (Pearson's coefficients >0.6). Using stepwise linear regressions we explored the significance of patch area and change on the species richness of the following groups: (i) total, (ii) broad specialists (i.e. species commonly found in herbaceous communities); and (iii) strict specialists (i.e. plants characteristic of the target phytosociological communities, and butterflies associated to these plants). We also performed a GLM comparing species richness of two patch sets with contrasting extent of habitat loss (0-20% and 60-99% of the original area lost), using present patch area as covariable. The latter was the only significant variable in the regression models and in the GLM. Therefore, habitat loss did not have a significant association with the richness of any species group, either when considering the original continuous variable (regression models) or two extreme categories (GLM). We conclude that no evidence from extinction debt is observed for the studied organisms in these grasslands.

Plant species diversity – Temporal changes and spatial determinants in agricultural landscapes

Cornelia Baessler (1), Peter Edwards (2) & Stefan Klotz (1)
(1) Helmholtz Centre for Environmental Research - UFZ, Dep. of Community Ecology; Theodor-Lieser Str. 4, 06120 Halle, Germany
(2) ETH Zurich, Institute for Integrative Biology, Universitätsstr. 16, 8092 Zurich, Switzerland

Agricultural intensification during the last century has caused fragmentation and isolation of semi-natural habitats in Central Europe landscapes. Furthermore, increasing use of fertilizer and pesticides has led to a deterioration of habitat quality, with a corresponding decline in plant species diversity. In this study we investigated the importance of historical and current land use and landscape structure for related plant species diversity pattern in semi-natural habitats. Historical and present field data of plant species in three agricultural landscapes in Central Germany were analysed in relation to land use and landscape structure parameters of the same periods (1950s, 1970s and 2000/2002). Changes in plant species richness and composition of semi-natural habitats at all and individually (meadows, woodlands, wetlands, dry grasslands) were estimated in each landscape. Plant species diversity of semi-natural habitats changed in the face of species richness and share of habitat specialists during last five decades mostly in favour of ruderal species. We found different pattern in the development of plant species richness in the studied landscapes depending on the land-use history and the different landscape structure pattern. Plant species richness of semi-natural habitats at all and of wetland habitats was negatively affected by the mean patch size of meadows and phosphorus application. Species richness of woody habitats was negatively affected by livestock density. We propose that this is an indirect affect primarily due to the positive relationship between livestock density and soil nutrient content. A fundamental concern regarding mineral fertilizer application, primarily phosphorus, is the observed reduction in biodiversity as many habitat specialists are replaced by generalist species. Thus, decline in habitat quality and species diversity cause changes in ecosystem functioning.

We conclude that not only landscape configuration, but also site quality variables play an important role in plant species richness pattern of semi-natural habitats within agricultural landscapes. Thus, the protection of habitat quality is as important for plant diversity conservation in agricultural landscapes as the protection of existing historically continuous patch mosaic systems of semi-natural habitats.

Land use change and long term biodiversity trends in pollinating insects and plants

Koos Biesmeijer, Claire Hutchins, Petr Keil , Bill Kunin.
Institute of Integrated and Comparative Biology and Earth and Biosphere Institute, University of Leeds, LS2 9JT Leeds, UK
Correspondence: j.c.biesmeijer@leeds.ac.uk

Recent initiatives of the Convention for Biological Diversity, the FAO and others argue that pollination services in the wild and in agriculture may be threatened and that pollinators need special attention as a key group in ecosystem functioning and in sustainable agriculture. Indeed, more than 75% of the world's major vegetable, fruit and seed crops [2] and a large share of the flowering plants depend on animals for their pollination, which suggests that pollinator loss may have considerable economic and ecological impact. It is now clear that in Britain pollinators, particularly bees, are declining and with them the wild plants they pollinate [1], but understanding of the causes of these changes remains in its infancy.

Documenting change in pollinator abundance and diversity relies on the availability of historical data, which are available only in some W-European countries and several dispersed location around the globe. Here we report on two different approaches to assessing the role of land use change (and other causes) in pollinator changes.

First, we analyze whether changes in UK land use over the last century may explain landscape-level changes in bee and hoverfly diversity.

Second, we compiled national-level data on bee status from national red lists and expert opinion for countries without a red list to provide an indication of the level of threat to wild bee populations. Next, we asked experts in all countries to give their opinion on the most important threats to each of the threatened bee species. We used threats based on IUCN categories, which include habitat loss/degradation (several subcategories), invasive alien species, pollution (several subcatgories), climate change, natural disasters, changes in native species dynamics (e.g. natural changes in food resources or hosts), and intrinsic factors (e.g. limited dispersal, low densities, restricted range).

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Connectivity analysis of the fragmented forest landscape of the Bereg Plain

Vera Vasas (1), Tibor Magura (2), Ferenc Jordán (3,4) & Béla Tóthmérész (5)
(1) corresponding author; Department of Plant Taxonomy and Ecology, Eötvös University, Pázmány P. S. 1/C, H-1117, Budapest, Hungary
(2) Hortobágy National Park Directorate, POB 216, H-4002, Debrecen, Hungary
(3) Animal Ecology Research Group of HAS, Hungarian Natural History Museum, Ludovika tér 2., H-1083, Budapest, Hungary
(4) Collegium Budapest, Institute for Advanced Study, Szentháromság u. 2, H-1014, Budapest, Hungary
(5) Ecological Institute of Debrecen University, POB 71, H-4010, Debrecen, Hungary

Maintaining connectivity among local populations in a fragmented landscape is a crucial point for the survival of many species. For isolated habitat patches, stochastic fluctuations and reduced gene flow can lead to high risk of extinction. This is probably true for carabid species (Coleoptera: Carabidae) living in the fragmented forests of the Bereg Plain (NE Hungary and W Ukraine). A new highway that is being planned through the area will further decrease the connectivity of the landscape.

Based on field data, we have drafted a landscape graph of the area representing the habitat network of carabid species. Graph nodes and links represented two kinds of landscape elements: habitat (forest) patches and corridors, respectively. The quality of habitat patches and corridors were ranked, reflecting local population sizes in the case of patches and estimated permeability in the case of corridors.

We thoroughly examined the constructed habitat network by means of network analysis in order to solve several issues that may arise in conservation practice. We investigated (1) the positional importance of landscape elements in maintaining the connectivity of the intact network, (2) the effects of establishing hypothetical green corridors, (3) the effects of improving the quality of existing corridors and finally (4) we constructed a plan to connect all patches in a cost-effective way. Our results set quantitative priorities for conservation practice: what to protect, what to build and what to improve.

The possible consequences of the planned highway was examined in detail due to their relevance. Our purpose was to (1) evaluate the disadvantageous effects of three possible highway tracks, (2) suggest a new solution that is realistically construable and much less disadvantageous for connectivity than the three others and (3) discuss how to decrease the disadvantageous effects of each track. Our results indicate that the intended highway could have deleterious consequences on forest-living carabids. Relatively simple actions, like the establishment of stepping stones, could compensate for the loss of landscape connectivity and promote the survival of carabids.

We believe that network analysis is a considerably powerful method in case of problems like this, and our main goal was to illustrate its usefulness in questions of land use management.

Linking changes of diversity of hoverflies (Diptera: Syrphidae) to climate and land use changes in Britain

Petr Keil (1,2), Jacobus C. Biesmeijer (2)
(1) Department of Ecology, Faculty of Sciences, Charles University, Vinicna 7, Praha 2, 12844, Czech Republic
(2) Institute of Integrative and Comparative Biology, Faculty of Biological Sciences, University of Leeds, Leeds LS2 9JT, UK

Recently, it has been shown that species richness of some important pollinator groups changed dramatically in Great Britain. The research presented here attempts to find the causes of the species richness changes in British hoverflies (Diptera: Syrphidae). In particular, we used the historical and present land use data to objectively quantify the change in extent of main habitat categories (urban, forest, grasslands, arable land, moorlands, gardens & orchards) during the 20th century. We also gathered data on changes of climatic conditions throughout the 20th century. We used these data to explain the historic and present patterns of species richness of hoverflies. Additionally, we examined not only changing patterns of pure species richness but also patterns of different functional groups.

Halobiotic Microlepidoptera and their relevance as ecological indicators for salt marsh monitoring

Corinna Rickert & Hartmut Roweck
Ecology Research Center University Kiel, Olshausenstr. 75, 24118 Kiel,Germany

Salt marshes expand in the wadden sea area on the coastline from Esbjerg in Danmark to Den Helder in the Netherlands and build a natural border between the sea and the mainland. Because of their unsheltered position, plants as well as animals of salt marshes are exposed to extreme living conditions which often result in high salt concentrations. They belong to the rarest ecosystems of Europe and have dramatically declined in recent decades [1] due to embankment and sea-level rise and their appearance is further threatened by intensive grazing.

Although salt marshes offer habitats to many insect species, yet only few parts of the entomofauna have been studied while many groups still need to be investigated and so far little is known about the ecology of terrestrial insect communities and even less about the effects of management measures or how to monitor them [2]. While still much of the autecology of halobiotic Microlepidoptera is unknown, small moths are known to be well adapted to the extreme living conditions in saltmarshes, many of them depend on special foodplants and often inhabit only certain parts of these plants. They build a manageable group of about 40 species and might thus be well suited as ecological indicators for the impact of threats mentioned above, especially grazing.

Preliminary results of 2006/ 2007 indicate an increase in species richness during the last 30 years when compared with data collected from 1968-75, which is clearly correlated to the abondonment of intensive grazing of saltmarshes after the establishment of the Wadden Sea Nationalpark in 1985. This tendency obviously seems to be confirmed when comparing data from grazed and ungrazed saltmarsh plots, which shows a higher diversity, more halobiotic species and a higher abundance in the ungrazed plots. Results indicate a strong impact of intensive grazing on the species diversity of Microlepidoptera while the impact of extensive grazing with less than 1.5 SU/ ha shows no effect (Fig. 1) and favors a high species diversity and abundance which implies a high value of extensive grazing for salt marshes. A well defined set of indicator species for the monitoring of salt marsh management turns out to serve as a helpful tool for conservation practice, too.

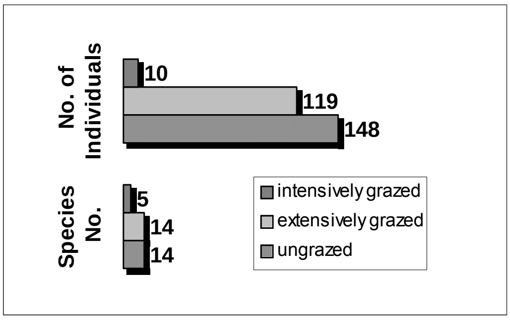

Figure 1: Numbers of species and individuals caught with photoelector traps in 2007 on the Hamburger Hallig.

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Genetic diversity and reproductive fitness of *Spergularia media* (Caryophyllaceae) in coastal and inland salt sites

Kathleen Prinz (1,2); Kurt Weising (1); Isabell Hensen (2)
(1) Plant Systematics and Morphology, University of Kassel, Germany
(2) Institute of Geobotany, Martin-Luther-University Halle-Wittenberg, Halle, Germany

In the past few decades, the sizes and biodiversity of natural inland salt marshes in Central Europe have experienced a tremendous decrease due to human activities. In contrast, anthropogenically influenced salt sites in the vicinity of potash mining dumps have become valuable secondary habitats for many halophytic species that are currently endangered in the natural landscape. Our study aims to examine the population genetics and relative fitness of *Spergularia media* (Caryophyllaceae) as a typical representative of C European halophytes that colonize both natural and anthropogenic salt-influenced habitats. Populations were sampled from several inland salt sites in C and SE Europe, as well as from coastal areas of the North Sea, the Baltic Sea and also the Mediterranean Sea. AFLP markers and nuclear microsatellites were used to determine the extent of genetic diversity and differentiation.

Highest genetic diversity values were generally found in the coastal populations, whereas the highest inbreeding coefficients were calculated for natural inland salt sites that were also characterized by small population sizes. These results are supported by reduced fitness values for inland plants. Populations from inland and coastal habitats were found to be genetically differentiated from each other, but we were unable to trace the origin of the populations from anthropogenic inland sites.

We conclude that low genetic diversity and strong genetic structure as well as reduced fitness of the inland populations are best explained by strong bottleneck effects, which may have been caused by founder events on anthropogenic salt sites, and by size reduction and isolation of natural salt meadows.

Research on Land Use Decisions and Ecosystem Degradation Relations on Gediz Basin, a Case Study on Gediz Delta.

Okan Yilmaz (1),Umit Erdem (1,2) , Serdar Selim (2), Seyma Sengur (1)
(1) Ege University, Agricultural Faculty Department of Landscape Architecture; Ege Ünivesitesi Ziraat Fakültesi C Blok 35100 Bornova, Izmir, Turkey
(2) Ege University, Center for Environmental Studies; Ege Ünivesitesi Fen Fakültesi A Blok 35100 Bornova, Izmir, Turkey

During the past times to nowadays Gediz River has an unique value for their environment as a natural resource. Its fertile soil has been provided a livable area for all creator for instance plants, animals and human. But last century human activities have been affected all area negatively. Thus, delta and whole basin of Gediz under threats of industrial activity, urbanization, wrong agricultural applications, irrigations, est.

The delta of Gediz is an important wetland of a category found in Turkey. 211 bird species of the total number of 426 species have been observed in Gediz delta. Also Gediz basin and delta has an important flora and fauna. However in the last century developing industry and human activities has been degraded all area. These factors indicate that how important the area is from the view of the bird species and natural life whose race are in danger to be extinguished and that ought to be protected.

Land use decision and ecosystem degradation of study area has been analyzed with Remote Sensing methods and relations among these analyses will be evaluated by Geographic Information System. Thus land use decisions are evaluated by overlay mapping techniques

The Influence of Global Warming on the Biodiversity of the Aquatic Organisms.

Tatjana Dovbysheva
International Humanitarian Economy Institute, Str.Gudro, 23-20, Minsk 220121, Belarus Тел.:+375 172 014569 or +375 296 782126, Fax + 375 172 102280, e-mail: tdovbysheva@bntu.by or tdovbysheva@yahoo.com

Warming will cause destruction of the wild nature and reduction of a biodiversity. The loss of a biodiversity is a loss of the important basis of maintaining of a life. At the present stage the biodiversity is considered actually as essential backbone natural resources both for a survival of the person and for his economic activities. Essential difference of the strategy on preservation of a biodiversity and the strategy on the reproduction and use of the natural resources consist in the ecosystem approach which are based on:

- notoverflow threshold levels of viability of components of a biodiversity
- the account of the factor of time at the analysis of development ecosystems
- maintaining stability of ecosystems
- the account of natural restrictions
- Foresight at acceptance of administrative decisions

Possible biotic consequences of change of a temperature regime of the pond, caused by warming of a climate, were investigated basically by the analysis of long-term data about a condition of natural ponds. On the basis of the analysis of the materials received on various ponds-cooling nuclear and thermal power stations, were defined the general tendencies of change of compound aquatic biota and character of spatial distribution of aquatic organisms in these conditions**.**

As shows the analysis of the results received at research of ponds for cooling in most cases at thermal pollution of ponds the general compound of kinds living in them remains constant. However quantity and character of spatial distribution of separate forms can essentially change. Kinds which earlier dominated became small number. More intensive development of kinds, minor on the value in the ecosystems is characteristic enough. Some of them become new dominants.

The warming of a climate shown in increase of average annual temperature, can cause essential infringement of seasonal dynamics of weather conditions, but will not lead to its full liquidation. To the certain climate there corresponds (makes) not only the certain degree of the thermophilic biota, but also character of life cycles of organisms existing in this period.. Often enough these properties (the attitude of an organism to the temperature factor and his life cycle) cause ambiguous reaction of a kind to change of climatic conditions. The majority of organisms in average and high latitudes intensively grow and develop only in the summer. The artificial heating of ponds increases duration of the period of active ability to live. In some cases aquatic organisms in ponds for cooling thermal and the atomic power station pass to year-round breeding. The similar phenomena are observed now and in natural reservoirs owing to climatic changes. **Abstract too long / cut; please correct abstract**

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Landscape agrarian intensification, farming intensity and weed diversity in NE Spain dryland cereal crop edges.

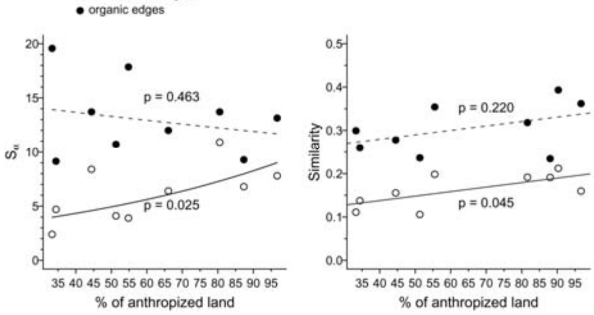
Albert Romero-Puente , Lourdes Chamorro, José M. Blanco-Moreno, Laura Armengot, Laura José-María & F. Xavier Sans
Universitat de Barcelona, Departament de Biologia Vegetal / Botànica; Diagonal Av., 645. 08028, Barcelona, Spain
http://www.ub.edu/agroecologia

Weed diversity in dryland cereal fields is related to management intensity and vicinity of the field margin, as reflected by the elevated levels attained in crop edges and organically managed fields [1]. Several studies have related landscape agricultural intensification, estimated through the percentage of arable land, with low levels of weed diversity at the field level in central Europe [2, 3]. We question if, in a Mediterranean context, landscape agricultural intensification is related to weed diversity of dryland cereal crop edges at the field level, but also to the floristic similarity among fields, for two clearly differentiated intensity levels of farming: organic and conventional. Nine cereal localities were selected in central Catalonia (NE Spain) in 2005. For each locality, the percentage of anthropized (arable + urban) land (hereafter, PAL) of a circular sector of 2 km radius was calculated using *CH50 Habitat Maps* and the weed vegetation of N=10 conventionally managed and N=7 organically managed cereal field edges scattered in the sector were surveyed. For each locality and management, total species richness surveyed across the crop edges (S_γ) was multiplicatively decomposed into its α and β components and tested for correlation with PAL. S_β was previously transformed to a similarity index = $[S_\beta^{-1} - N^{-1}] / [1 - N^{1}]$ to allow the comparison among managements. Floristic similarity among conventional crop edges was positively associated to landscape intensification, and species richness at the crop edge level (S_α) followed the same trend, especially when only dicot species were taken into account (Fig. 1), suggesting the existence of a homogenous and well-established pool of ruderal weed species in intensified landscapes. Conversely, weed diversity in organic dryland cereal edges was less dependent of landscape intensification, with the exception of characteristic arable weeds –i.e. weeds whose habitat is restricted to arable land, which exhibited higher total species richness (S_γ) in less intensified landscapes (Tab. 1). Our results point out the complex interactions between crop management intensity and agrarian intensification in the conformation of weed flora in cereal crop edges.

Table 1: γ species richness (minimum, median, maximum) of characteristic arable weeds and its correlation with PAL for organic and conventional crop edges (*, $P < 0.05$).

	S_γ	ρ
Organic edges (7 edges per locality)	(3, **8**, 14)	- 0.73*
Conventional edges (10 edges per locality)	(1, **4**, 8)	+ 0.05

Figure 1: S_α (left) and similarity (right) of dicot weed species in conventional and organic crop edges against PAL.



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[2] Roschewitz et al., 2005. J Appl Ecol, 42: 877-882.
[3] Gabriel et al., 2005. Perspect Plant Ecol Evol Systemat, 7: 85-93. **abstract too long for print**

Landscape context on generalist and specialist aphid natural enemies

B. Caballero-López (1), R. Bommarco (2), J. M. Blanco-Moreno (1), F. X. Sans (1), J. Pujade-Villar (3) & H. G. Smith (4)
(1) Department of Vegetal Biology, Faculty of Biology, Barcelona University, Diagonal Av., 645 08028-Barcelona, Spain
(2) Department of Ecology, Swedish University of Agricultural Sciences, P.O. Box 7044, SE-750 07 - Uppsala, Sweden
(3) Department of Animal Biology, Faculty of Biology, Barcelona University, Diagonal Av., 645 08028-Barcelona, Spain
(4) Department of Animal Ecology, Ecology Building, Lund University, 223 62 - Lund, Sweden

A landscape-scale research approach has been highlighted by a growing body of literature as essential for understanding important ecosystem services as biological control. Aphids are victims of a diversity of enemies making the aphid-enemy interaction a nice example for the role of enemy diversity for the functioning of biological control. Here we examined the effects of landscape complexity on cereal aphids and associated natural enemies that varied in the degree of specialization.

Abundances of specialist (Coccinellidae) and generalist predators like Carabidae were significantly higher in simple landscapes since can benefit from the high availability of a variety of alternative resources within cropping systems. Consequently coccinellidae-to-aphid ratio and predatory Carabidae-aphid ratio were significantly higher in fields in homogenous landscapes as compared to fields included in an heterogeneous landscape, suggesting that enemy pressure on cereal aphids increases with landscape simplification. Conversely, to what was expected, arable fields in high intensity agricultural landscapes with little non-crop areas can support a similar abundance and diversity of cereal aphid parasitoids as structurally complex landscapes.

In conclusion, the landscape effect will depend mainly on the degree of specialization of functionally dominant natural enemies, so that our results imply that conservation actions aiming to optimise abundance for one taxonomic group in the agricultural landscape will not automatically increase abundance of other groups. Hence, it is essential to focus the future empirical work in examining the schedule of agricultural landscapes that enhance at the same time generalist and specialist natural enemies.

Rapid adaptation of the Bluethroat (*Luscinia svecica*) to oilseed rape as a new agricultural habitat in the Upper Rhine floodplain

Anja Berndt, Norbert Hölzel & Hermann Mattes
University of Muenster, Institute of Landscape Ecology; Robert-Koch-Str.28, 48149 Muenster, Germany

In the course of the rapidly extending cultivation of renewable primary products and bioenergy production especially oilseed rape has become an outstanding element in many German and European agricultural landscapes. So far ecological impacts on landscape structure and biodiversity have received relatively little attention. Due to monotonous structure and high biocide applications, oilseed rape is often critically considered by ecologists. However, for some rare and endangered species oilseed rape may form a suitable habitat. Surprisingly, this also applies to the bluethroat (Luscinia svecica cyanecula) in the floodplain of the northern Upper Rhine in Germany. This species was formerly completely confined to natural (reeds) and seminatural (overgrown ditches) wetland habitats. First records of the bluethroat in oilseed rape fields in the late 1990s were followed by a rapid expansion to this new agricultural habitat, documented by three surveys between 2001 and 2007. Data from these surveys were used to model habitat preferences in oilseed rape by means of logistic regression. Our analysis shows that bluethroats exclusively occupy oilseed rape fields, which are located in the holocene floodplain of the Rhine whereas fields at the lower terrace as a rule remained unoccupied. Logistic regression models confirmed a close correlation between soil moisture namely proximity to the groundwater level and occupancy. Moreover, the availabilty of ditches can upgrade habitat quality, whereas the occurrence of reed (Phragmites australis) at the outskirts of oilseed rape fields turned out to be insignificant. Given a suitable degree of soil moisture, oilseed rape stands alone may provide all essential habitat requisites.

Effects of dispersal barriers on the population structure of the obligate myrmecophyte *Macaranga winkleri* (Euphorbiaceae)

Christina Baier & Frank R. Blattner
Leibniz Institut für Pflanzengenetik und Kulturpflanzenforschung (IPK), Corrensstr.3, 06466 Gatersleben, Germany

Knowledge of the ecology and population dynamics of pioneer species is important for the understanding of regeneration processes of tropical rainforests, and is therefore essential for conservation management. In times of loss of natural habitats and fragmentation, due to agricultural areas, urbanisation and infrastructure development, a good comprehension of the effects of land use changes on biodiversity functions and population dynamics is needed.

The genus *Macaranga* consists of about 300 shrub and tree species with paleotropical distribution from western Africa to some Pacific islands. The genus comprises some of the most important pioneer tree species of lowland dipterocarp forests in Southeast Asia. While in primary forests the pioneer species of *Macaranga* are restricted to forest gaps, they have become some of the most conspicuous trees in logged areas. About 30 Southeast Asian *Macaranga* species are obligate myrmecophytes, i.e. they provide food and nesting space to their ant partners in exchange for protection against herbivores and lianas. In these obligate relationships ants and plants are not able to survive without each other. The species under study, *M. winkleri*, is an obligate myrmecophyte, with 100% specificity to its ant partner from the genus *Crematogaster* (morphospecies 8).

Species life history traits may play a role in determining dispersal abilities in fragmented landscapes. We here analyse if an obligate myrmecophyte is more heavily affected by habitat fragmentation, as both mutualistic partners are needed to found a new population. Is *M. winkleri*, therefore, struck more intensely by fragmentation then *Macaranga* species, which do not have to co-disperse with their ant partners? To answer this question we compare genetic variability and phylogeographic structure of this myrmecophyte with non-myrmecophytic *Macaranga* species using both nuclear and chloroplast microsatellites. As myrmecophytes have always to co-disperse with their specific ants we expect to find higher geographic differentiation in them in comparison to non-myrmecophytes, which do not rely on specific ants to mature. In first analyses we found no significant differences between *M. winkleri* and the non-myrmecophyte *M. tanarius*. Analysis of the data indicate a weak population genetic differentiation with very low genetic variance among populations and high variance within the populations in both species, suggesting high levels of gene flow. However, in a region of Borneo were huge oil palm plantations interrupt a forested area on one side of this barrier *M. winkleri* occurs with only low abundance and no ant-inhabited individuals could be found. All individuals higher than 20 cm were suffering from fungal infections, climbers, and herbivores and no plants higher than one meter were found. This observation shows that the plants are able to cross the barrier, as seeds are partly dispersed by birds. The corresponding ants, however, are not able to follow their hosts across this distribution barrier. Thus, although *M. winkleri* populations seem well-connected in general, habitat fragmentation influences even this pioneer species, in this case through dispersal restrictions on its mutualistic ant partner.

Rearrangement of ground beetle (Coleoptera: Carabidae) assemblages by urbanisation

Tibor Magura (1), Gábor L. Lövei (2) & Béla Tóthmérész (3)
(1) Hortobágy National Park Directorate; POB 216, H-4002 Debrecen, Hungary; e-mail: magura@hnp.hu
(2) University of Aarhus, Department of Integrated Pest Management, Faculty of Agricultural Sciences; Flakkebjerg Research Centre, DK-4200 Slagelse, Denmark; e-mail: gabor.lovei@agrsci.dk
(3) Department of Ecology, University of Debrecen; POB 71, H-4010 Debrecen, Hungary; e-mail: tothmerb@delfin.klte.hu

Urbanisation is increasing worldwide and today half or more of the human population lives in cities. Urbanisation causes the original, lightly disturbed rural area to become more patchy and disturbed by the appearance of human habitation and development (suburban or peri-urban areas). At its core, cities are densely populated, built-up, developed and often highly disturbed areas, with isolated fragments of the original habitat remaining. These phases of urbanisation seem to be similar all over the globe, but it is unknown whether these will cause similar changes in biodiversity. Comparative ecological studies, done in different locations but using the same treatments can help to answer this question. We examined whether urbanisation has similar effects on biodiversity in different locations, comparing the responses of ground beetle (Coleoptera: Carabidae) assemblages to an urbanisation gradient in nine temperate locations. We used data collected in the international Globenet project that examines how urbanisation affects arthropod biodiversity of an originally forested area undergoing urbanisation using a rural-suburban-urban gradient approach. We formulated and tested the following predictions: (1) Urbanisation, starting from an originally forested habitat, will decrease the diversity of ground beetles ("increasing disturbance hypothesis"). This hypothesis would predict an overall decrease of diversity as a result of disturbance. However, different elements of an assemblage may react differently, because the specialists are expected to decrease by the effects of urbanisation while the generalist species could be favoured ("habitat specialist hypothesis"). (2) Urbanisation will homogenise ground beetle faunas and create similar assemblages in cities, thus the ground beetle assemblages in urban forest fragments would be more similar to each other than to their rural counterparts, at least within a geographical region. The overall ground beetle diversity, evaluated by scalable diversity ordering using the Rényi diversity function showed inconsistent trends. When only forest specialist species were included, there was a consistent, robust relationship in the diversity of the forest specialist species: in all nine study sites, the forest specialist sub-assemblages were more diverse in the rural area than in the urban one. This indicates that we have found qualified support for the habitat specialist hypothesis because urbanisation caused pronounced decrease in the diversity of the forests specialist species. The homogenisation hypothesis was not supported, as the rural faunas were more similar to the urban ones within the same country than any urbanisation stage to each other within the three geographical regions (North-western Europe: Belgium, Denmark, England and Finland; South-eastern Europe: Bulgaria, Hungary and Romania; overseas countries: Canada and Japan). Urbanisation apparently did not homogenise ground beetle faunas in cities across the studied countries. (Research was supported by the Hungarian Scientific Research Fund; OTKA grant no. F61651).

Distribution of bees on Hungarian autumn-sown cereal fields cultivated with different intensity

Anikó Kovács (1), Péter Batáry (2,3) & András Báldi (4)
(1) Szent István University, PhD School of Environmental Sciences, Páter K. 1, 2103 Gödöllő, Hungary
(2) Hungarian Natural History Museum, Department of Zoology; Ludovika tér 2, 1083 Budapest, Hungary
(3) Georg-August University, Agroecology, Waldweg 26, 37073 Göttingen, Germany
(4) Animal Ecology Research Group of the Hungarian Academy of Sciences and the Hungarian Natural History Museum, Ludovika tér 2, 1083 Budapest, Hungary

Pollination is one of the most important ecosystem services. Agricultural landscape, which covers two-thirds of Hungary, could support hostile areas for pollinators, however the intensification of the cultivation may be a serious threat to bees. The conservation of the relatively high biodiversity of Hungarian agricultural landscapes is important to maintain the unique biota of the Pannon biogeographic region. We investigated the effects of fertilisers and pesticides on the bee diversity of autumn-sown cereal fields. We chose five farmers in Central-Hungary in 2005, who cultivated their lands with different levels of intensification. Altogether we could differentiate seven land-use intensities. First we let them fill a questionnaire about the use of fertilisers and pesticides. In all intensities we chose 3-3, altogether 18 fields (there was one intensity with only one field and an other with only two).

On each field two yellow water pans filled with water were put out: one in the edge, in the first cereal rows and one 50 meter away in the interior. We opened them six times in May and June. They were checked in every seven days. We also conducted a botanical survey on 95 m long transects in the edge and interior of each field.

For the statistical analyses data of the six sampling periods were pooled. Beside the total species richness and abundance, species were grouped according to three life traits: length of the tongue (short vs. long), nesting customs (ground nesting vs. non-ground nesting) and body-size (small vs. large). The effects of fertiliser (amount of Nitrogen/ha/year), herbicide (application number) and landscape (amount of semi-natural habitats in a 500 m buffer area) were tested with general linear models. In separate models the effects of vegetation structure (plant species richness, weed cover, wheat height and bare soil surface) were investigated.

Our data set consisted of 4882 individuals of 95 species. According to our results fertilisers had significant positive effect on the total species richness and total abundance. There were significantly more bees in the interior part of the fields than in the field edge. Fertiliser had significant positive effect on the abundance of short-tongued bees, on the species richness and abundance of ground nesting bees, on the species richness and abundance of the small bees, and on the abundance of large bees. Herbicide use had significant negative effect on the abundance of ground-nesting bees and on the abundance of small bees. Neither the percentage of semi-natural habitats nor vegetation structure affected the bees.

We can conclude that on these fields the fertiliser use increases, the herbicide use decreases the number of bees. However, we should add that our “intensive” fields were similar to the extensive ones in Western Europe. We should say that bees are influenced mainly by the agriculture management; therefore their protection on such landscapes should be conducted through the regulation of agriculture.

Contrasting responses of bees and hoverflies to land-use intensity – why "pollinator" fails as a functional group

Frank Jauker (1), Birgit Meyer (2, 3) & Volkmar Wolters (1)
(1) Justus Liebig University, Department of Animal Ecology, Heinrich-Buff-Ring 26-32, 35392 Giessen, Germany
(2) Georg August University Göttingen, Agroecology, Waldweg 26, 37073 Göttingen, Germany
(3) Hessisches Landesmuseum Darmstadt, Friedensplatz 1, 64283 Darmstadt, Germany

Declining availability and accessibility of semi-natural habitats in temperate regions have been identified as major drivers of the decline in numerous taxa and the associated ecosystem functions. The connectivity of focal habitat patches, however, might be altered by "quality" factors of the surrounding matrix. The strength of these effects is likely dependent on specific ecological traits of species within functional or taxonomic groups. Empirical data supporting this assumption regarding pollinators mainly derive from studies conducted with one pollinator taxon, the bees. We present data from two independent studies that show contrasting responses to landscape characteristics of two families within the pollinator guild.

Wild bees and hoverflies were recorded in 32 calcareous grasslands around the city of Göttingen (Lower Saxony, Germany) and the impact of the surrounding landscape on the community structure was assessed. Furthermore, both taxa were recorded along six transects of 2 km length originating in grassland conservation areas and spreading into an intensively managed agricultural landscape in the Wetterau region (Central Hesse, Germany). In both cases, landscape characteristics generally regarded beneficial to pollinators (e.g. landscape diversity, distance to semi-natural habitats) positively influenced wild bee communities, but had no or a negative effect on hoverfly communities.

We argue that generalizing effects of land-use change for all pollinators might not only fail within, but already between taxonomic groups differing in critical ecological traits like central place foraging. Moreover, components of community structure might be affected differently, as diversity and abundance of hover flies responded contrarily. Thus, maintenance of ecosystem functioning (by means of high abundances) might counteract biodiversity (by means of species richness).

Generalisation of plant-pollinator food webs in fragmented habitats

Birgit Meyer (1), Ingolf Steffan-Dewenter (2)
(1) Hessisches Landesmuseum Darmstadt, Department of Natural History, Zoology, Friedensplatz 1, 64283 Darmstadt, Germany
(2) University of Bayreuth, Department of Animal Ecology I, Population Ecology, Universitätsstraße 30, 95440 Bayreuth, Germany

Plant-pollinator systems are under increasing threat from anthropogenic factors such as the reduction of suitable habitat. Fragmentation may cause decreasing pollinator diversity and consequentially disrupt plant-pollinator interactions. For conservation purposes, it is necessary to identify those habitats that are best suited to preserve ecosystem functioning and those pollinator species that are most at risk of extinction.

Plant-pollinator interactions were assessed in 32 calcareous grassland fragments in Southern Lower Saxony, ranging in size from 0.03 to 5.14 ha. We noted occurrences of bee species and visitation of flowering plants during six 20-minute-transect walks throughout the entire vegetation period of 2004.

The distribution of bee species over the differently sized calcareous grasslands followed a positive species-area relationship. Analyses with the nestedness calculator BINMATNEST and Spearman's rank correlations revealed that the bee communities are significantly nested and that species pools in smaller calcareous grassland fragments are subsets of species pools in larger fragments. A regression model further showed that the proportion of oligolectic species, i.e. bees that visit only a narrow range of plant species, increases with increasing habitat area. Correspondingly, a food web analysis confirmed that plant-pollinator webs in larger calcareous grasslands are more specialised than in small fragments. Hence, large calcareous grassland fragments have higher species richness and the species that are lost in smaller fragments are primarily specialised bee species.

We can conclude that it is important to conserve large calcareous grassland areas in order to preserve species richness of bees, especially specialised species, and therefore ensuring the functionality of plant pollinator interaction webs.

Effects of plant population structure on flower visitation and seed set of wild plants at two spatial scales: a pan-European approach

Jens Dauber, Jacobus Biesmeijer, Doreen Gabriel, William E. Kunin, Ellen Lamborn, Birgit Meyer, Anders Nielsen, Simon Potts, Virve Sõber, Ingolf Steffan-Dewenter, Jane Stout, Tiit Teder, Thomas Tscheulin, Daniele Vivarelli, Theodora Petanidou
University of Leeds, Institute of Integrative and Comparative Biology; Leeds LS2 9JT, UK

Fragmentation and loss of seminatural habitats have become increasingly common phenomena in European landscapes, leading to a likely decline in plants and their pollinators [1]. Small plant populations often fail to recruit sufficient numbers of pollinators. This can lead to pollination limitation, which reduces plant fitness and impedes the long-term survival of small populations [2]. The structure and spatial distribution of plant individuals within populations can have an effect on the number of pollinator visits and on the composition of deposited pollen.

To disentangle the causes of pollination limitation, we studied flower visitation and seed set of 10 different plant species in 75 populations in several fragmented habitats in 5 European countries. We focussed on both size and density of plant occurrence at two spatial scales, the population (i.e. all plant individuals of a focal species occurring in a habitat fragment) and the patch scale (i.e. distinct aggregations of the focal plant species within a population).

We have found the general pattern that seed set and flower visitation are primarily controlled by variables at the patch level, with higher number of visitors and seed set in larger and denser patches. For number of flower visitors we also found a significant interaction between patch size and patch density describing a higher number of visitors in large patches with intermediate flower density. In these models population level variables did not appear to have significant effects, suggesting that flower visitors move towards the plants based on behavioural decisions that are made on a relatively fine scale. Seed set in all plants increased with increasing patch extent and density. Population area was only significant in interaction with patch area and patch density, showing that the effects of patch extent and density are only apparent in small populations but not in large ones. The pattern of a strong patch level control was found both when modelling all 10 plant species and only the 8 self-incompatible (SI) species. In contrast, number of flower visitors appeared to have a significant effect on seed set only in SI plants.

We believe that effects of "rarity" (as defined by size and density of flower patches) interact between population and patch level, thus pollen limitation is controlled by processes operating at different spatial scales. Small plant populations do not seem to be more threatened than large populations, but important is the attractiveness of the flower patches at scales perceived by the pollinators.

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[2] Leimu, R., et al. (2006) How general are positive relationships between plant population size, fitness and genetic variation? Journal of Ecology, 94, 942–952.

Additional resource or competition for pollinators? The impact of oilseed rape on bee diversity and rare plant pollination in adjacent grasslands

Andrea Holzschuh (1), Carsten F. Dormann (2), Ingolf Steffan-Dewenter (3) & Teja Tscharntke (1)
(1) Agroecology, University of Göttingen, Waldweg 26, 37073 Göttingen, Germany
(2) Helmholtz Centre for Environmental Research-UFZ, Department of Computational Landscape Ecology, UFZ, Permoserstr. 15, 04318 Leipzig, Germany
(3) Animal Population Ecology, University of Bayreuth, Universitätsstraße 30, 95440 Bayreuth, Germany

Bees may connect oil seed rape (OSR) fields, which provide temporarily very abundant food resources, and noncrop habitats, which provide nesting sites, during foraging trips. While the area of noncrop habitats in central Europe has decreased during the last years, the area of mass-flowering OSR fields enormously increased due to demand for biofuels. However, information on the positive or negative effects of OSR on the diversity of solitary bees nesting in noncrop habitats and the pollination of wild plants in noncrop habitats is lacking. We hypothesized that solitary bees nesting in noncrop habitats may benefit from the additional food resources provided by OSR resulting in a higher proportion of OSR pollen in their nests and a higher number of brood cells per female. However, the pollination and seed set of wild plant species flowering simultaneously in noncrop habitats may be reduced when bees favour nearby mass flowering crops over wild plants.

Bees were recorded along transects and in trap nests in 34 OSR fields and 34 protected calcareous grasslands. Half of the OSR fields and grasslands were adjacent to one another. The control areas were isolated from calcareous grasslands and OSR fields, respectively. Additionally, in each grassland, we recorded the seed set of the self-incompatible plant *Primula veris* which flowered on calcareous grassland during rape flowering.

Wild bees nesting in calcareous grasslands foraged in adjacent OSR fields, but *Primula veris* was not found to profit or suffer from adjacent rape fields. Few wild bees were recorded in OSR fields without calcareous grassland nearby. The proportion of OSR pollen in trap nests was significantly higher in OSR fields and calcareous grasslands adjacent to rape fields than in isolated grasslands. Cross-habitat fluxes between noncrop habitats and flowering crop fields may be important for maintaining high bee abundance and diversity in agricultural landscapes. However, OSR fields without noncrop habitats in their surrounding were apparently without value for wild bees, and OSR pollination may be reduced in those fields.

Effects of an alien invasive plant on native plant and pollinator communities

Anke C. Dietzsch & Jane C. Stout
Trinity College Dublin, Department of Botany, School of Natural Sciences; Dublin 2, Ireland

Pollination is recognised as a key ecosystem function ensuring the reproduction of the majority of plant species. Although plant-pollinator networks show a high level of plasticity they are exposed to and threatened by anthropogenic activities worldwide. One of the pressures on plant-pollinator interactions is the ongoing increase in alien species that invade native communities and alter not only community structures but also native ecosystem processes.

Little is know about the impacts of alien plant species on native plant and pollinator species at a community level. Alien plants might compete with native species for pollinators by luring them with showy flowers and abundant floral rewards. Alternatively, they might facilitate native species' pollination by providing a larger overall flower display. Pollinator communities may include alien plants in their diet and benefit from their resources or from substitution of declining native plants. If so, they may link alien species with co-flowering native plant species forming a complex pollination web. Alternatively, pollinators may be harmed if alien species produce toxic secondary compounds or displace native plants.

The aim of this project was to assess the impacts of an alien invader, *Rhododendron ponticum*, on native plants and pollinators in Ireland. *R. ponticum* is severely invasive in the UK and Ireland and mainly visited by bumblebees, in particular *Bombus lucorum*, *B. pascuorum* and *B. hortorum*, in its invasive range. We examined flower visitation of all co-flowering plant species in invaded and uninvaded natural field sites. Furthermore, we investigated the effects of different flower abundances of the invasive plant on flower visitation and seed set of a native model species, *Digitalis purpurea*. The alien is known to contain grayanotoxins, and so we also investigated the suitability of alien flower rewards for bumblebees at an individual and population level.

Using observational and manipulative field experiments as well as molecular methods and feeding experiments, we found facilitative effects of *R. ponticum* on flower visitation in some native plant species at some sites with low to medium *R. ponticum* coverage. However, *R. ponticum* had contrasting impacts on *D. purpurea* seed production at different flower abundances. Furthermore, pollen and nectar rewards of *R. ponticum* did not harm worker bumblebees, and invaded field sites were used by a higher number of colonies of *B. lucorum* and *B. pascuorum* than uninvaded field sites.

We conclude that the alien represents a valuable foraging resource for social bees. As a result, invaded plant communities can support more colonies of bumblebees than native plant communities do. The larger number of pollinators can facilitate native plant pollination, however effects on native plant pollination vary with flower abundance in time and space.

Solanum elaeagnifolium, an American plant invading Mediterranean: comparative pollination ecology in native and invaded habitats

Theodora Petanidou (1), Nickolas M. Waser (2), Scott Allen (3), Afroditi Kantsa (4), Nickolaos Krigas (4), and Judith L. Bronstein (3)
(1) University of the Aegean, Department of Geography, University Hill, 81100 Mytilene, Greece
(2) School of Natural Resources, University of Arizona, Tucson, AZ 85721, USA
(3) Department of Ecology & Evolutionary Biology, University of Arizona, Tucson, AZ 85721, USA
(4) Laboratory of Systematic Botany and Phytogeography, Department of Botany, School of Biology, Aristotle University of Thessaloniki, GR-54124, Thessaloniki, Greece

Invasive alien plants pose a threat to biodiversity and ecosystem functioning, because they may displace native plants and crop species due to competition for resources including pollinators. Competition for pollination services can potentially result in the deposition of heterospecific pollen (reducing pollen quality) or/and in lower visitation (reducing pollen quantity). Both processes may eventually lead to lower seed set of the native plants. However, there have also been cases in which invasives have a positive or neutral effect on visitation frequency and/or seed set. For instance, invasives could provide additional resources for pollinators, which could lead to an overall increase in the abundance, diversity, or geographic range of pollinators, or even in the duration of pollinators' foraging season, thus facilitating pollination of the native plants.

This study explores whether the pollination behaviour of a plant species changes with the phytogeographical status (native vs. invasive alien) and whether this is related with its invasiveness. *Solanum elaeagnifolium* was chosen as a model, a plant species that is native to the SW USA to C and S America. The species is a widespread alien in many regions of America including the USA and in several regions of the Old World. In the Mediterranean, S. Africa, and Australia it is considered a pest. Throughout its range, it is mainly associated with disturbed lands and is well-adapted for dispersal through vegetative growth and seeds.

The novelty of this study is that it compares research results taken in parallel in the original (Arizona, USA) and invasive (Greece) range, employing the same protocols. Four types of populations of *S. elaeagnifolium* were studied: wild native (6 populations, Arizona); expansive native (6 populations, Arizona); naturalized alien (3 populations on Lesvos island, Greece); and invasive alien (14 populations in Thessaloniki, N. Greece). In all areas the species flowers in summer and it is buzz-pollinated by bees native to each area that belong to similar ecological guilds. In the study we addressed the following issues regarding *S. elaeagnifolium*: (i) its extent of invasion in Greece; (ii) its mating system in relation to the state of invasion (Arizona, Greece); (iii) its dependence on insect pollination and potential for sexual reproduction in wild and invasive populations (Arizona, Greece); (iv) the existence of competition for pollination posed on this species by other co-flowering species in wild populations of *S. elaeagnifolium* (Arizona); and (v) the interference of *S. elaeagnifolium* in native plant–pollinator interaction networks in the invaded areas (Lesvos).

This research project is financed by the E.U.-European Social Fund (80%) and the Greek Ministry of Development-GSRT (20%). Financial support was also received from the FP 6 Integrated Project ALARM and the Fulbright Foundation.

Nature, bees, and marzipan: can wild insects contribute to almond pollination in California?

Alexandra-Maria Klein (1,2), Elisabeth Johanna Eilers (1,2), Miriam Voss (1,2), Claire Kremen (1)
(1) Department of Environmental Science, Policy and Management, 137 Mulford Hall
UC Berkeley, California 94720-3114, USA
(2) Agroecology, University of Göttingen, Waldweg 26, 37073 Göttingen, Germany

Luebeck is a small German city, known for its excellent marzipan industry. But why refer to marzipan when discussing biodiversity and ecosystem functioning like pollination services? Some marzipan recipes contain honey, which can be linked to honey bees, but even more important all marzipan recipes contain almonds as a main component. At this point ecological relationships and interactions are becoming important for a global industry. Bee pollination is a key process and critical step for almond production. Hence Californian almond producers rely on renting honey bees to ensure production. To Date, nothing is known if, which, and how many wild bee or fly species forage on almonds and in which ways they interact or complement honey bee pollination. Here, we will present recent findings showing that wild bees and flies are foraging on almond flowers, but only when orchards are surrounded by a high proportion of natural habitats. Orchard management with organic practices are only becoming important for providing nesting and flowering resources for bees when high proportion of natural habitat is surrounding the orchards. Besides honey bees, solely syrphid flies were found in highly isolated landscapes in organic, but rarely in conventional orchards. We will further show if pollinator community structure and foraging activity change at specific spatial parts of the tree or orchard.

Using different microscopic methods like fluorescence staining for pollen germination (Table 1), electron microscopy to identify varietal pollen grains, and species-specific behavioral observations during foraging, we will discuss pollination efficiency of wild insect species guilds for almond pollination.

Table 1: Number of pollen tubes detected in the stigma, penetrated the ovule, and percent stigmas with tubes penetrating the ovule after a single visit of an individual of 4 pollinator groups: syrphid flies, mainly *Syrphus* sp., nectar-foraging honey bees, pollen-foraging honey bees; Halictidae, mainly *Evylaeus* sp., Andrenidae, *Andrena cerasifolii*, LSD interval test with log-transformed data to separate significantly different groups.

pollinator guilds	#pollen tubes detected	#pollen tubes ovule	stigmas with tubes penetrating ovule (%)
syrphid flies	5.4±4.8[a]	0.3 ±0.7 [a]	22
honey bees, nectar forager	9.6±6.8[ab]	1.3±1.3 [b]	61
honey bees, pollen forager	12.4 ±7.1[b]	1.5±1.4 [b]	65
Halictidae	39±17.4[c]	4.3±2.6 [c]	100
Andrenidae	50.3±58.1 [c]	5.7±3.7 [c]	96

We will end by discussing possible implications and future research needs to help an industry that relies on a single pollinating species. **Abstract too long/cut**

Pollination and seed predation in a landscape perspective: the red clover system

Maj Rundlöf (1), Anna Persson (1), Maya Johansson (1), Riccardo Bommarco (2) & Henrik G. Smith (1)
(1) Department of Ecology, Lund University, Sölvegatan 37, 223 62 Lund, Sweden
(2) Department of Ecology, Swedish University of Agricultural Sciences, Uppsala, Sweden

Ecosystem services, such as pollination and biological control, are benefits that nature provides to humanity, and can influence the size and quality of crop yields. Agricultural intensification and structural changes in agricultural landscapes have a major influence on the world's ecosystems. Several studies have shown that by reducing agricultural inputs and preserving semi-natural habitats farmland biodiversity can be promoted [e.g. 1, 2, 3], which may influence agricultural productivity.

The seed production in red clover (*Trifolium pratense*) depends largely on two factors; insect pollination and seed predation. Red clover depends on cross-pollination, primarily by bees, for satisfactory seed set. As a counteracting force, clover is attacked by seed eating pest insects, mainly Apion weevils, which reduce the seed production.

In this project, we aim at understanding how the landscape context influence pollination and seed predation, and have used red clover as the model system. We designed a study system, in southern Sweden, consisting of 4 landscape types; landscapes with a large proportion of pasture, landscapes with organically managed small fields, landscapes dominated by conventionally managed small fields and landscapes dominated by large conventionally managed fields, with 6 landscapes of each type. Two pot of red clover were placed in the centre of each of the 24 landscapes. The pollinating insect visiting the potted clover were recorded and collected during three observation rounds to each pair of pots during 2007. Seed eating weevils were observed on the plants during observations and flower heads were collected for hatching of the weevils. Bee bowls and standard inventory transects were used to monitor the present pollinator community and flower resources in the landscapes.

The preliminary results indicate that there are notably differences in the number of visits of pollinating insects to the clover depending on the surrounding landscape context, with the highest visitation rate in pasture landscapes and the lowest in large field landscapes. Bumblebees are the most frequent visitor, followed by butterflies, but the organism groups and species that account for the visits differ between the four landscape types. The weevils also exhibit a landscape dependent abundance, although partly different from the pattern of pollinators. Our findings show that the landscape context can influence the providers of ecosystem services and possibly affect agricultural productivity. The project will run 2008-10 and aims to develop management schemes to enhance the ecosystem services pollination and biological pest control in clover seed production, at the landscape, farm, and field level [4].

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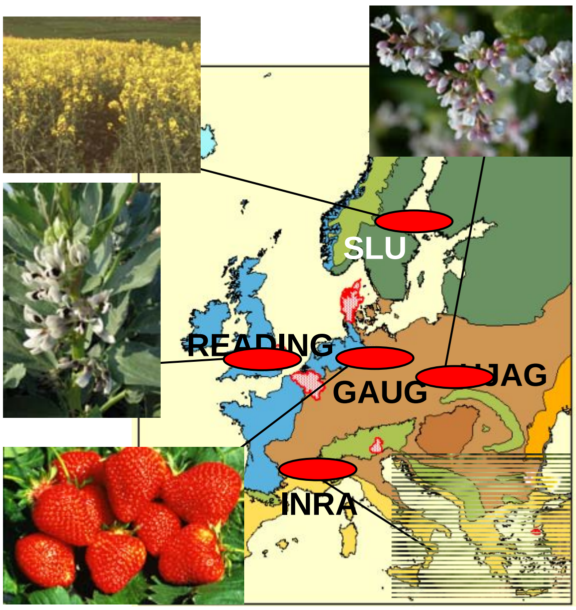
Assessing the insect pollination service to annual crops in changing landscapes across Europe

Bernard E. Vaissière (1), Gabriel Carré (1), Riccardo Bommarco (2), Kristin Krewenka (3), Nicolas Morison (1), Simon G. Potts (4), Stuart P.M. Roberts (4), Ingolf Steffan-Dewenter (5), Hajnalka Szentgyörgyi (6), Catrin Westphal (5), Michal Woyciechowski (6)
(1) NRA, UMR 406 Abeilles et environnement, 84914 Avignon cedex 9, France
(2) Department of Ecology, Swedish University of Agricultural Sciences, SE-75007 Uppsala, Sweden
(3) Department of Agroecology, Georg-August-University, Göttingen, Germany
(4) Centre for Agri-Environmental Research (CAER), School of Agriculture, Policy and Development, University of Reading, RG6 6AR, Reading, UK
(5) Institute of Animal Ecology I, Department of Population Ecology, University of Bayreuth, 95440 Bayreuth, Germany
(6) Institute of Environmental Sciences, Jagiellonian University, ul. Gronostajowa 7, 30-387 Kraków, Poland

In Europe, 80% of crop species are dependent upon or benefit from pollination by insects, and mostly bees. Insect pollination is both a major ecosystem service that contributes to human well-being and a production practice used by farmers. Wild bees contribute to the pollination of most crop species and their importance are increasingly recognised since their interaction with honey bees can significantly enhance their overall pollinating activity. Yet significant declines have been reported for wild bee populations and honey bee colonies alike in Europe and there is clear evidence that land use changes has affected bee populations in abundance and diversity.

We quantified the effect of landscape context on bee communities and the pollination service they provide in annual entomophilous field crops over 7 to 10 sites located over a gradient of increasing semi-natural habitats in five pairs of crop-European country : buckwheat *Fagopyrum esculentum* in Poland, cantaloupe *Cucumis melo* in France, field bean *Vicia faba* in the UK, spring oilseed rape *Brassica napus* in Sweden, and strawberry *Fragaria* x *ananassa* in Germany. Bees were sampled at each site sites and CORINE Land cover classification was used to characterize the landscape over a 3 km radius around each study site. Pollination service was measured on a whole plant basis, rather than using flower samples. To this end, all the flowers of individual plants were treated to quantify the levels of autonomous self-pollination, wind pollination by airborne pollen flow, or insect pollination. We used multivariate and regression analyses to quantify the impact of landscape features on bee abundance and biodiversity as well as on the contribution of the insect fauna to the overall crop yield. The results will be presented and discussed.



Indices, graphs and null models: tools for elucidating the ecological causes of bipartite network topology

Carsten F. Dormann (1), Jochen Fründ (2), Nico Blüthgen (3) & Bernd Gruber (1)
(1) Helmholtz Centre for Environmental Research, Department of Computational Landscape Ecology, Permoserstr. 15, 04318 Leipzig, Germany
(2) Agroecology, University of Göttingen, Waldweg 26, 37073 Göttingen, Germany
(3) Department of Animal Ecology & Tropical Biology, University of Würzburg, Biozentrum, Am Hubland, 97074 Würzburg, Germany

Many analyses of ecological networks in recent years have introduced new indices to describe network properties. As a consequence, several indices are available to address the same question, differing in specific detail, sensitivity in detecting the property in question, and robustness with respect to network size and sampling intensity. Furthermore, some indices merely reflect the number of species participating in a network, but not their interrelationship, calling for a null model approach. Here we introduce a new, free software calculating a large spectrum of network indices, visualising bipartite networks and generating null models. We use this tool to explore the sensitivity of over 20 network indices to network dimensions, sampling intensity and singleton observations. Based on 19 observed pollination networks, we investigate the interrelationship of these indices, and show that they are largely redundant, and heavily influenced by network dimensions and connectance. Finally, we re-evaluate five common hypotheses about network properties based on a comparison of the 19 pollination networks with three different null models: 1. The number of links per species ("degree") follow (truncated) power law distributions. 2. Generalist pollinators interact with specialist plants, and vice versa (dependence asymmetry). 3. Ecological networks are nested. 4. Pollinators show a checkerboard distribution, owing to specialisation within the network. 5. Ecological networks are more robust to extinction than random networks. Our results indicate that while some hypotheses hold up against our null models, others are to a large extent understandable on the basis of network size, rather than ecological interrelationships. In particular, null model pattern of dependence asymmetry and robustness to extinction are opposite to what current network paradigms suggest. Our analysis, and the tools we provide, enables ecologists to readily contrast their findings with null model expectations for many different questions, thus telling statistical inevitability from ecological process.

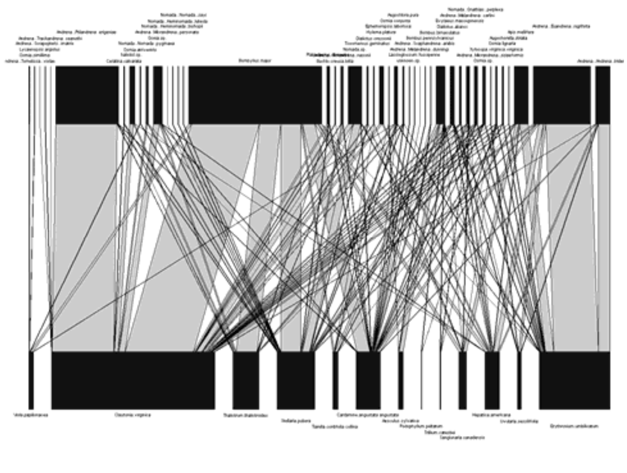


Figure 1: The bipartite graph of a pollination network. Sequence of species minimises crossing of lines. Dataset: A. F. Motten (PhD Thesis, Duke University, 1982).

Plant–pollinator interaction web: a stochastic procedure?

Kallimanis A.S. (1), Petanidou T. (2), Tzanopoulos J. (3), Pantis J.D. (3), Sgardelis S.P. (3)
(1) Department of Environmental and Natural Resource Management, University of Ioannina, 30100, Agrinio, Greece
(2) Department of Geography, University of the Aegean, University Hill, 81100 Mytilene, Greece
(3) Department of Ecology, Aristotle University, 54124, Thessaloniki, Greece.

Plant-pollinator interaction network are characterized by several features (nestedness, power law distribution of degree specialization, temporal turnover) that cannot be obtained from a totally random network, that is unrealistic because species are active for only a part of the year, and so a plant that flowers in spring cannot interact with a pollinator active in autumn. We build a stochastic model to simulate the plant-pollinator interaction, taking into account the duration of activity of each species. In our simulated annual cycle we know which plant and pollinator species are active, and thus available to form interaction. We can obtain simulated plant-pollinator interaction networks with properties similar to the real ones in one of two ways: (i) by assuming that the frequency distribution of both plant and pollinator duration of availability follow an exponential function, and that interaction among coexisting species are totally random, and (ii) by assuming more realistic frequency distributions (exponential for pollinators, lognormal for plants) and that the interaction among coexisting species is occurring on a per capita basis. We assume that there is a relationship between abundance and duration of activity. We conclude that the observed plant-pollinator network properties can be produced stochastically, and the mechanism creating the network is not related to size constraints, preferential attachment to generalists, or coevolutionary explanations

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Poster presentations

The Swiss agri-environment scheme enhances pollinator diversity and plant reproductive success in nearby intensively managed farmland

Matthias Albrecht (1), Peter Duelli (2), Christine B. Müller (2), David Kleijn (3) & Bernhard Schmid (1)
(1) University of Zürich, Institute of Environmental Sciences; Winterthurerstrasse 190, 8057 Zurich, Switzerland
(2) Swiss Federal Institute for Forest, Snow and Landscape Research; Zürcherstrasse 111, 8903 Birmensdorf, Switzerland
(3) Wageningen UR, Alterra; Droevendaalsesteeg 3, 6708 PB Wageningen, The Netherlands

Agri-environment schemes are attempts to counteract the loss of biodiversity and associated ecosystem services such as pollination and natural pest control in agro-ecosystems. Only few studies, however, have evaluated if these attempts are successful. We studied the effects of meadows managed according to the prescriptions of ‘ecological compensation areas’ (ECAs), the most widely adopted agri-environment scheme in Switzerland, on both, pollinator species richness and abundance and the reproductive success of plants, in nearby intensively managed meadows. We experimentally set up arrays of four pots, each containing individuals of three insect-pollinated, non-autogamous “phytometer“ species (*Raphanus sativus*, *Hypochaeris radicata* and *Campanula glomerata*) in ECAs and in adjacent intensively managed meadows at increasing distances from the ECAs at 13 sites. Species richness and abundance of hover flies, solitary bees and large-sized pollinators (mainly social bees and butterflies) were significantly higher in ECAs than in adjacent intensively managed meadows. Species richness and abundance of small-sized pollinators in intensively managed meadows declined significantly with increasing distance from ECAs, whereas large-sized pollinators were not significantly affected by distance. Plant species richness and flower abundance were the major drivers of pollinator species richness and abundance; the area of an ECA had no significant influence. Individual plants of *R. sativus* and *C. glomerata* produced more and heavier seeds in ECAs than in intensively managed meadows. Furthermore, the number of seeds of these two phytometer species was positively correlated with species richness and abundance of bees. The number of fruits and seeds per plant of *R. sativus* in intensively managed meadows decreased with increasing distance from ECAs. We conclude that establishing ECAs is an effective agri-environment scheme to enhance both pollinator species richness and abundance and pollination services to nearby intensely managed farmland. Our results justify incentives to achieve minimum botanical quality standards in ECAs, as targeted by new Swiss law. Our study also emphasizes the importance of connectivity between ECAs in maintaining diverse pollinator communities and thereby providing pollination services in agricultural landscapes

Farming system transitions, biodiversity change and ecosystem services

Georg Andersson (1), Henrik Smith (1)
(1) University of Lund, Department of Animal Ecology, 223 62, Lund.

Agricultural landscapes shape large parts of earths ecosystems, and can be both a threat to and a promoter of biodiversity depending on the farming practice and/or intensification [1]. During the last century there has been major intensification in agricultural landscapes and large declines in semi-natural habitats. This affects not only biodiversity but also the ecosystem functions. These include goods such as food and services such as pollination. To get a more general understanding of organisms and their interactions among them selves as well as with their environment, landscape ecology can be applied. Studies of landscape effects on biodiversity most often focus on the spatial distribution and quality of habitats, but the time-scale is not equally well studied. How historical processes effects the configuration of biodiversity and ecosystem function is of great importance to more efficiently set up management to prevent further losses. In Europe environmental schemes have been set up to be an incentive to farmers to manage their farms in a more environmentally friendly way. Organic farming is one of these schemes and has been argued to benefit biodiversity [2], but effects have been shown to depend on landscape context [3]. In this research project I will study how organic farming, and the time since transition from conventional farming, affects pollinator diversity and the pollination services they perform. I will also study if these differ with landscape context. This can have implication on how to evaluate the effects of organic farming in different landscapes and how subsidies are regulated. The main research questions to be answered are:

How does organic farming affect pollinator diversity and pollination services?

Does the diversity of pollinator affect the pollination service?

Does the time since transition to organic farming affect the diversity and pollination services?

We will use organic farms, situated in landscape with similar structure but with different time since transition from conventional to organic. A set of conventional farms will be used as control. This set up will be contrasted in two landscape types with differing complexity and farming insensitivity. We will use traps and transects with hand nets on the farms to examine the diversity of wild bees and syrphid flies. We will also perform inventories of the food resources, i.e. wild flowers. To examine the effects on pollination on farmland crops we are going to set up experiments on crop flowers. The expectation is that diversity will increase with time since transition to organic farming. This will happen faster in complex landscapes than in simple. The pollination services may benefit from organic farming, more so in simple ones, intensively manage landscapes than in complex and extensively manage landscapes. The time lags will probably be shorter in complex than simple landscapes.The poster will show the results from the first season, this summer.

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Phytodiversity dynamics in short rotation coppice (SRC)

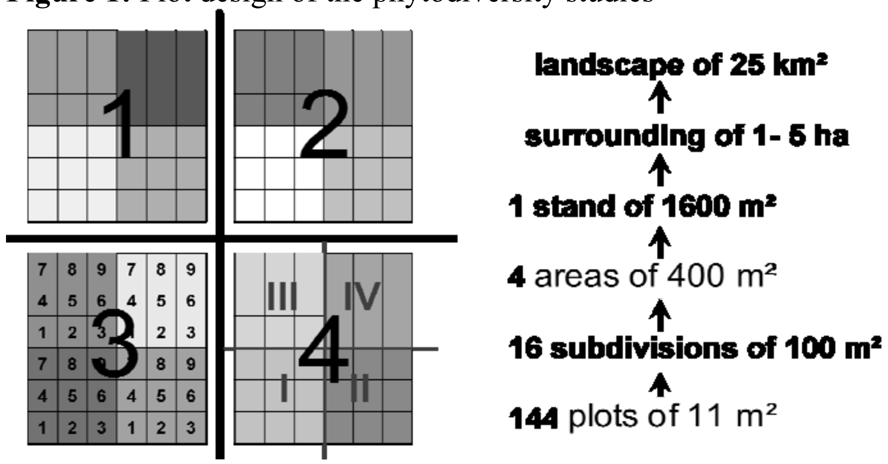
Judith Bielefeldt (1), Heino Wolf (2), Franz Kroiher (1), Andreas Bolte (1)
(1) Johann Heinrich v. Thünen-Institute, Institute of Forest Ecology and Forest Inventory; Alfred-Möller-Straße 1, 16225 Eberswalde, Germany
(2) Public Enterprise Sachsenforst; Bonnewitzer Straße 34; 01796 Pirna OT Graupa, Germany

Increasing prices for fossil fuels and enhanced efforts to reduce the CO_2 emissions induced a growing demand for renewable energy sources. Within this context, woody biomass from short rotation coppice (SRC) on fallow grounds may contribute significantly. Besides economical incentives, SRC may also influence ecological services and the biological diversity of the landscape. The NOVALIS project, started in Sept. 2006 and funded for three years by the Deutsche Bundesstiftung Umwelt (DBU) aims to evaluate such ecological effects of SRC. The project activities include studies on the phytodiversity dynamics in short rotation coppice (SRC); this is done in close co-operation with the public enterprise Sachsenforst (PES) at Graupa.

The pool of plant species in seven poplar SRC (age one to more than ten years) and adjacent habitats, and the changes of species composition due to land-use intensity were investigated in 2007. Effects of SRC on plant species diversity were evaluated on different spatial scales from parcel level (11 m² surface) to stand or patch level (1,600 m² surface) using a nested grid design (Figure 1). On three of these SRC sites, the vegetation has been previously assessed twice a year by PES staff from 1998 to 2005. This was done on 40 plots, each 25 m² in size using the Braun-Blanquet method. Combining the two survey data to a nine year time series, vegetation and phytodiversity dynamics for almost the entire vegetation period can be investigated.

First results point to a change of driving factors on phytodiversity in SRC with the increasing stand age. Whereas site conditions and site preparation are important factors on plant species abundance and diversity in the first years, stand structure and crown characteristics become indicative of composition und diversity of the understorey vegetation in later stages.

Figure 1: Plot design of the phytodiversity studies



Ecological considerations on biodeterioration of the cultural heritage

Corneliu Bucşa
University "Lucian Blaga" of Sibiu, Ecology and Environment Protection Departmen, Dr. I. Raţiu Str. 5-7, 550012, Sibiu, Romania.

The subject (the purpose) of this work is to demonstrate that the assessment and the efficient control of biodeterioration, the cultural heritage protection by means of the "green" methods, require an ecological approach.

There were studied more than 3oo historically important buildings and 11 open air museums in Romania, especially wood destroying insects and fungi and their conditions of existence.

There are presented the following results about: the biodiversity analysis of the studied organisms; the relationship between xylophagous insects and fungi; the habitats and the occurrence of the species taken into consideration; the peculiarity of the environment especially the microclimate and its influence on the colonization and the growth of the pests; the key factors for the evolution of the biological populations.

Finally, there is emphasized the importance of this analysis methods of biodegradation for integrated pests management.

Effects of habitat loss and fragmentation on pollinator diversity and pollination services

Caitriona Cunningham, Mark Brown & Jane Stout
Trinity College, Dublin, Ireland

Habitat loss and fragmentation are thought to be the primary anthropogenic threats to biodiversity. Agricultural intensification causes habitat loss and fragmentation because modern agricultural methods reduce the botanic diversity in farmland, both in fields and in the reduction in the amount of natural uncultivated land. This project will examine how agricultural intensification impacts on pollinator diversity and pollination services. Pollinators are important in agricultural and natural ecosystems because a high proportion of plants require animal vectors for the transfer of pollen and hence successful seed set.

Selected areas of landscape in Co. Clare will be classified according to component habitat types. We will then investigate if there is a relationship between pollinator abundance and diversity and a) local floral diversity, and b) surrounding habitat types. In addition, we will look for a relationship between pollinator abundance and diversity and pollination services to selected focal plants. Finally we will work out the proportion of agricultural and other habitats which maximise pollinator abundance and diversity and pollination services, and document how these habitats are spatially distributed and connected.

Factors affecting species diversity of marginal habitats in an agricultural landscape of Western Wolhynia (southeastern Poland)

Joanna Czarnecka & Bożenna Czarnecka
Maria Curie-Skłodowska University, Department of Ecology, Akademicka Str. 19, 20-033 Lublin, Poland; e-mail: a_czarnecki@wp.pl

Numerous plant and animal species have adapted to the living conditions of the men-shaped environment. The crucial role in agriculture landscape is played by marginal habitats and linear structures, such as roads and roadsides, arable field boundaries, balks, hedgerows, shelterbelts, ditches and stream verges. They lessen the degree of isolation of environmental islands (e.g. patches of grasslands and forests), maintain and enrich biodiversity of croplands, play the role of refuges, dispersal corridors and propagule sources [1, 3]. Modernisation of agriculture, the increasing use of fertilisers and herbicides, and the development of large-scale farms are responsible for the disappearance of weeds from arable fields and the removal of small linear landscape elements [2].

The aim of the present study was to answer the following questions: 1. Which linear landscape structures in the agricultural landscape of Western Wolhynia are the centre of plant diversity? 2. Which factors are responsible for the distribution of rare plant species along the linear structures?

The observations were conducted in the agriculture landscape surrounding the Natura 2000 site Żurawce (PLH 060029; habitat 6210 – semi-natural dry grasslands on calcareous substrates with important orchid sites). Linear structures, mainly bulks and roadsides, play the role of refuges and dispersal corridors for xerothermic grassland species. Rare, xerothermic weed species connected with dry and calcareous habitat were strictly limited to the field margins. Their abundance was negatively correlated with the intensive, large-scale farming system (Fig. 1). They are connected with wide, dry, insolated margins of arable fields. These species are stress tolerators (high temperatures and draught) with a high level of resistance to man-made disturbances.

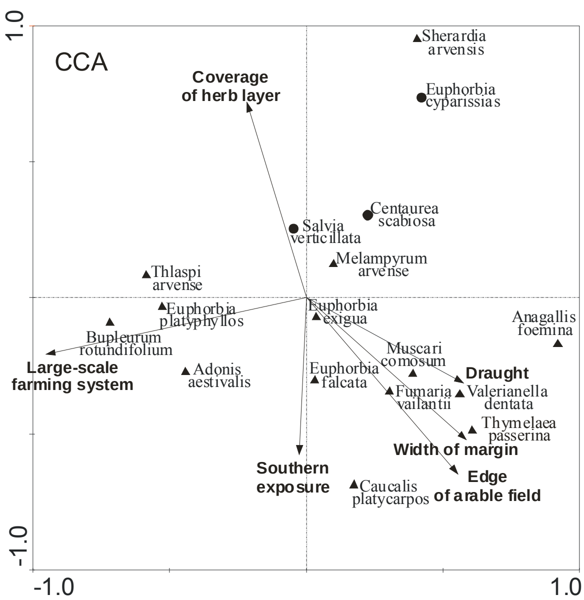


Figure 1: The main factors affecting spatial distribution of species along margins of arable fields (results of CCA, circle – grassland species, triangle – weeds)

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Habitat fragmentation, plant-animal interactions and plant fitness – an experimental approach

Annette Kolb
Vegetation Ecology and Conservation Biology, Department of Ecology and Evolutionary Biology, University of Bremen, Leobener Str., D – 28359 Bremen, Germany.

In fragmented landscapes plant species are often confined to remnants of formerly more widespread habitats, with many of their populations being small and isolated. In such populations, interactions with both mutualistic and antagonistic animals may be disturbed, setting up a potential trade-off of costs and benefits of fragmentation. Habitat fragmentation, via reductions in plant population size and increased isolation, may not only directly affect plant-animal interactions, but may also modify interactions through effects on the species' genetic population structure.

The first objective of this study was to experimentally investigate the direct effects of habitat fragmentation on both mutualistic and antagonistic plant-animal interactions and to examine how these influence plant reproduction, using the perennial forest herb *Phyteuma spicatum* (Campanulaceae). I experimentally manipulated plant population size and isolation using plants from one population and environment (i.e. plants that are likely to have a similar genetic constitution), observed pollinator behavior and visitation, determined the intensity of herbivory and estimated the joint effects of pollination and herbivory on plant reproductive success. A second objective of this study was to distinguish between the direct effects of population size and isolation on plant-animal interactions and the effects on plant response to interactions with animals via effects on the genetic constitution of plants. In a second experiment, I therefore used offspring plants of natural populations of varying size and degree of isolation (i.e. plants that are likely to have a different genetic constitution), exposed them to the same environment without manipulating population parameters and determined the intensity of herbivory as well as plant reproductive success.

The results suggest 1) that small population size decreases reproductive success via direct negative effects on plant-pollinator interactions, 2) that this pattern is not offset by herbivory, but 3) that herbivory enforces fragmentation effects on pollination by further reducing the number of flowering individuals, and 4) that habitat fragmentation may influence plant fitness by affecting plant susceptibility to herbivore damage. The effects of habitat fragmentation on plant populations in present-day landscapes are thus manifold, illustrating the need for more integrated studies in conservation biology.

Does environmental change reduce pollination success by wild bees?

Susann Parsche, Jochen Fründ & Teja Tscharntke
Georg August University of Goettingen, Department of Crop Science, Agroecology;
Waldweg 26, 37073 Goettingen, Germany

Habitat modification and human-induced climate change are having a severe impact on ecosystems already. Plant-insect interactions in particular might be disrupted due to different responses towards those changes. Consequently, key pollinators such as bees and flowering plants are liable to suffer from increasing asynchrony of their life cycles. We are investigating how wild bee communities respond to human-induced environmental change and whether it affects pollination service to a model plant. By means of a manipulative field study we have been simulating habitat fragmentation, seasonal shift and nitrogen enrichment as aspects of global change. For that purpose we established sixteen habitat islands of potted plants, *Sinapis arvensis* L., either in close proximity to or at 500-1000 m distance from calcareous grasslands which are known to be one of the most biodiverse habitats with species-rich bee communities but which are also particularly sensitive to environmental change. These model plants were monitored during two different periods representing natural and experimentally anticipated flowering respectively. Furthermore two different heights of flowers were compared, simulating enhanced growth caused by nitrogen enrichment. We collected data on flower visitation and quantified the seed and fruit set. Our objective is to examine potential differences in pollinator assemblages of *Sinapis arvensis* on the basis of a) close proximity versus distance to calcareous grassland, b) early versus natural flowering and c) natural versus experimentally enhanced height of the flowers. We will present data on community composition, abundance and species richness of wild bees as well as on pollination success under the above-mentioned simulation treatments.

Effects of exurban sprawl on population dynamics of the spur-thighed tortoise in southeast Spain

Irene Pérez (1), José Daniel Anadón (2), Rubén Ballestar (1), Alicia Tenza (1) & Andrés Giménez (1)
(1) Universidad Miguel Hernández. Dpt. Biología Aplicada, Área Ecología. Av. Universidad s/n Edif. Torreblanca, 03202 Elche, Alicante, Spain
(2) Dpt. Ecological Modelling, UFZ Center for Environmental Research, Leipzig D04301 Germany

Exurban sprawl is one of the most important threats to biodiversity. Together with the direct effects of urbanization (e.g. habitat loss and fragmentation), the practices of residents toward native species (such us feeding, collecting…) in new exurban areas could be crucial for conservation. In the present work, we quantify the diffuse effect of collecting an endangered terrestrial tortoise (Testudo graeca) by residents of new exurban areas in southeast Spain; where the main population of this species is present and where, since the last decades, there is an important urban development. For this purpose, a system dynamics simulation model has been developed. The model developed includes two submodels interconnected through tortoises collected: tortoise population dynamic and new residents dynamic. Spur-thighed tortoise life history parameters were derived from scientific bibliography and own data. Parameters values of the residents submodel were obtained by means of interviews to new residents of residential areas within the distribution area of the species. We used this model to explore the long-term effects of the practices of collect tortoises from wild population. Our model predicts that a new residential area of ca 3700 inhabitants might cause the extinction of the species in the surrounding landscape due to the collection of wild tortoises. Possible management measures area discussed. This study highlights the importance of controlling urbanization development in natural areas of high ecological values, and of incorporating the human dimension in the management of new urbanized areas.

Comparative analysis of structural characteristics of ground beetles community (Carabidae: Coleoptera) along an urban-rural gradient in Skopje city and its surrounding

Dana Prelik (1), Aleksandra C. Gorgievska (1), Slavco Hristovski (1) , Ljubomir Penev (2)*
(1) Institute of Biology, Faculty of Natural Sciences and Mathematics, Gazi Baba bb, 1000 Skopje, Macedonia
(2) Biodiversity Department, Central Laboratory of General Ecology, 2 Yurii Gagarin Street, 1113 Sofia, Bulgaria

Comparative analyze of structural characteristics of ground beetles in three different localities (urban - U, suburban - S and rural - R) along the urban-rural gradient in Skopje city and its surrounding was followed.

The material was collected monthly, during one year period (07.2004 – 07.2005) by pitfall trapping along a transect.

The presence of 60 species was registered, belonging to 27 genera. In total 109.06 ind.trap^{-1} were registered, in R - 41.00 ind.trap^{-1}, in S – 30.46 ind.trap^{-1} and in U - 37.60 ind.trap^{-1}.

The investigation of structural features of ground beetles (Carabidae: Coleoptera) comparatively in three different localities has been done trough examination of structural characteristics such as Index of richness – d; Index of diversity – H'; Index of homogeneity – $J_{(e)}$; Index of dominance - DI and Index of similarity - S.

There were similar oscillations of d (index of richness) and H' (index of diversity) which had highest values during early summer period and lowest during February. J(e)- (index of homogeneity) varied in tighter frames. Values of H' and $J_{(e)}$ were almost identical and positively correlated. DI (index of dominance) was negatively correlated with the other indexes. Highest values were registered during February in R and May in S, while lowest during July in S. Index of similarity (S) was highest between urban and rural locality (66.67%) in winter period.

Different structural characteristics of ground beetle community between localities were due to differences of ecological conditions.

Patch size and isolation effect on mixed-oak forest vegetation diversity

Gloria Rodríguez-Loinaz, Miren Onaindia & Ibone Amezaga
Department of Plant Biology and Ecology, University of the Basque Country, P.O. Box 644, E-48080 Bilbao, Spain

Patch size and patch isolation effect on the diversity of five different vegetation types, i.e. herbaceous plants, climbing plants, shrubs, trees and ferns was analysed in mixed-oak forests in Bizkaia (northern of the Iberian Peninsula). Only the diversity of herbaceous plants and ferns were negatively affected by these variables, specially that of forest typical species. This type of vegetation responded quicker to these effects possibly due to their higher fragility that lead to a quicker disappearance of the site in response to the effects of the reduction of patch size (patch quality) and the increase of isolation due to their low dispersal capacity. Thus, conservation policies should concentrate mainly in these vegetation types in order to evaluate the positive or negative effect of their actions.

Land use dynamics and its consequences for biodiversity

2.2. Drylands in a changing world: Key elements of sustainable land use under conditions of high environmental variability

Anja Linstädter, Karsten Wesche

Oral presentations

Local vs. scientific knowledge – Importance of woody species as key elements in local perception

Jenny Eisold (1), Silke Tönsjost (2) & Anja Linstädter (1)
(1) University of Cologne, Institute of Botany; Gyrhofstr. 15, 50931 Köln, Germany
(2) University of Cologne, Institute of Cultural and Social Anthropology, Albertus-Magnus-Platz, 50923 Köln, Germany.

In the complex interaction between socio-economic and environmental challenges, solely scientific approaches might be an insufficient response to changing human-environment relationships. To gather more profound knowledge on sustainable natural resource management it is crucial to implement the knowledge of local land-users and contrast it with current scientific knowledge. However, methods to achieve this are still scarce. We say that this can only be obtained by truly interdisciplinary approaches.

This study directly contrasted environment perception of pastoralists and range ecologists regarding local key forage species in a semi-arid savanna ecosystem. This was done by analysing an anthropological and a botanical dataset of local key plant species, with the same methodology. The aim was to gather new insights concerning decision-making processes in natural resource management.

The local key forage species were identified using freelisting and pile sorting, anthropological methods from Cultural Domain Analysis (CDA). The results were contrasted with the ecological performance and frequency of the local plant species.

We found that local and scientific perception differ significantly (t-test, $p < 0,05$) and that in local perception woody species have a higher importance than in scientific perception. We conclude that biomass availability as fodder in dry season makes species valuable in local perception. Thus we can say that not performance or frequency of a plant species makes it a key element in the local context but reliability in scarce times.

This study confirms the importance of incorporating local knowledge to understand important aspects of local decision-making processes. Local knowledge can act as a point of reference for scientific knowledge and provide a more complete understanding of important aspects in local natural resource management. We highly recommend that scientists should incorporate the insider's view of land users to get a more complete picture of the human-environment system of interest.

The non-equilibrium theory – a comparison between existing data and a new climate data set

Henrik von Wehrden (1,2), Jan Hanspach (3), Petra Kaczensky (2) & Karsten Wesche (1,4)
(1) Martin-Luther-University Halle-Wittenberg, Institute of Biology - Geobotany and Botanical Garden, Am Kirchtor 1, 06108 Halle/Saale, Germany, E-mail: HenrikvonWehrden@web.de
(2) Research Institute of Wildlife Ecology, Savoyen Strasse 1, Vienna, 1160 Austria
(3) UFZ Helmholtz-Centre for Environmental Research, Theodor-Lieser-Str. 4, 06120 Halle, Germany
(4) University of Göttingen, Albrecht-von-Haller-Institute for Plant Sciences, Dep. of Ecology and Ecosystem Research, Untere Karspüle 2, 37073 Göttingen, Germany

The non-equilibrium theory emphasises climatic variability as the principal driver of livestock numbers in arid and semi-arid rangelands. However, this paradigm has been repeatedly challenged since its original postulation. We assessed the current state of the discussion by collecting published field studies which evaluated rangeland health indicators. These were compared based on a krigged layer of annual precipitation variability, which we processed from coefficients of variance (CV) calculated for records of annual precipitation from ~19000 stations.

Studies originated from all the arid and semi-arid rangelands throughout the world (n=58), with the majority coming from Africa. The most commonly quoted rangeland health indicator was vegetation cover; yet biodiversity, species and life spectra composition were also frequently assessed. Biomass, productivity and soil dynamics were rarely explicitly examined. The majority of studies identified spatially widespread degradation; others focused on gradients radiating from non-zonal spots such as wells and rivers. Some studies concentrated on animal impact around key resource areas such as saline meadows, and only a few of the reviewed studies encountered no degradation. Degradation was however restricted to sites with a CV≤33 % or non-zonal situations. The few studies that recognized no degradation at a CV≤33 % came from areas with old established grazing regimes or from ecosystems which were totally altered due to a changed in fire frequency or by invasive species.

Our meta-analysis supports the original postulation that degradation is restricted to regions with low precipitation variability or to 'equilibrated' or severely disturbed ecosystem. It is however concerning that several studies (n=16) explicitly assumed non-equilibrium conditions, even though their sites were located in rangelands with relatively stable (=equilibrium) precipitation variability. Moreover, the majority of studies did not examine the precipitation CV at all (n=38).

Because only a minority of the examined studies reported no degradation (n=6), data are apparently biased towards equilibrium dynamics. Furthermore, most of the applied rangeland health indicators imply at least partly reversible degradation, while permanent degradation, as indicated by e.g. soil erosion, is less frequently examined. These facts need to be considered in order to further understand non-equilibrium dynamics and their dependence on precipitation variability. Our map of the precipitation variability offers a globally comparable source of information in this context.

Detecting long-term trends in non-equilibrium rangeland systems – a matrix model approach

Birgit Müller (1), Anja Linstädter (2), Jula Zimmermann (1), Karin Frank (1)
(1) Helmholtz-Centre for Environmental Research – UFZ, Permoserstr.15, 04318 Leipzig, Germany
(2) Botanical Institute, University of Cologne, Gyrhofstr. 15, 50931 Köln, Germany

Impacts of grazing and rainfall on vegetation dynamics are difficult to separate in non-equilibrium rangeland systems. We present an approach, which helps to determine the relative impact of the stochastic abiotic factor (rainfall), and the interactive biotic factor (grazing) on long-term vegetation dynamics in this highly variable environment.

For this purpose two steps of analysis are carried out: Firstly an expert system is formulated which indicates the relationship of season-dependent grazing pressure under different rain levels on vegetation dynamics from one year to the next (we call it here GRV Expert System). More precisely the expert system is based on a classification of perennial ground cover states. Secondly, a matrix model approach is applied to detect long-term trends for different grazing regimes under stochastic rainfall. Matrix models are an established method to model age classes and conduct population viability analyses of endangered species. This study shows its further potential for detecting long-term trends of arid rangelands under different grazing regimes.

Exemplarily the approach is demonstrated for the perennial grass layer at the range management system of the semi-nomadic Himba in northern Namibia which is dominated by the species Stipagrostis uniplumis. This management system combined traditionally season-dependent pasture use (resulting in rainy-season pastures and dry-season pastures) and preservation of reserves for drought.

The study shows that apart from grazing pressure, the time of grazing (all year round or only in the dry season) strongly affects perennial grass cover on large temporal scales. Furthermore we demonstrate how sensitive the results are for parameters as seed-bank longevity and probability of seed entry, and we discuss possible consequences of climate change.

Concluding, the use of a GRV Expert System linked with matrix analysis offers a promising methodological approach to detect long term vegetation trends and extinction risks caused by the combined effects of grazing and environmental variability typical for arid rangelands. This offers the possibility for risk assessment of different grazing regimes.

Furthermore, we derive recommendations for the design of field experiments aimed at understanding the relationship between grazing and rainfall in stochastic environments

Linking plant traits to abundance: a diachronic approach in sheep grazed and fertilized calcareous rangelands

Adeline Fayolle (1), Marie-Laure Navas (1,2), Daniel Hubert (3), Paul Autran (4), Pablo Cruz (5) & Eric Garnier (1)
(1) CNRS-CEFE, UMR 5175, 1919, Route de Mende, 34293 Montpellier Cedex 5, France
(2) Montpellier SupAgro, UMR 5175, 2 Place Viala, 34060 Montpellier Cedex 1, France
(3) INRA-ERCC, UMR 868, 2 Place Pierre Viala, 34060 Montpellier Cedex 1, France
(4) INRA, Unité expérimentale de La Fage, 12250 Roquefort sur Soulzon, France
(5) INRA-AGIR, UMR 1248, Chemin de Borde Rouge, BP 52627, 31326 Castanet Tolosan Cedex, France

Agricultural practices strongly impact community structure and functional diversity, thus modifying ecosystem functioning and associated services. Here, we quantified vegetation response to mineral fertilization associated to sheep grazing in a long term experiment. With a diachronic approach we examined the floristic and functional response of herbaceous plant communities. Then we linked species abundance patterns over time to biological traits. The study was conducted at the 'La Fage' experimental station, located on a limestone plateau in southern France. Since 1978, an intense sheep grazing treatment associated to mineral fertilization (N, P) is applied on two paddocks of 6.7 Ha each. Botanical records were performed yearly on 16 point-quadrat survey lines, 8 per paddocks. Functional traits - morphological, physiological or phenological characteristics - of both dominant and minor species were screened in 2006 and 2007. Fertilization associated with grazing induced a significant variation of community structure. Rangelands initially composed of herbaceous perennials significantly shifted to mixed communities, with a proportion of annuals increasing from 1 to 50% in 30 years. We then established three response groups based on species abundance dynamics - increasing, decreasing or neutral abundance pattern over time - and compared functional traits between groups. We clearly identified biological characteristics of increasers, which have a high specific leaf area (Fig. 1) and leaf phosphorus content, a low leaf dry matter content and a short and early flowering period. Increasers are thus fast growing species exhibiting a trait syndrome of rapid acquisition and use of resources. Neutral species were not different from increasers. Decreasers exhibit the opposite trait syndrome of slow-growing conservative species. Intense sheep grazing associated to mineral fertilization affected both community composition and functional structure. We identified in this dry system a shift from stress tolerant to ruderal species with increasing fertility and disturbance, as stressed in more temperate systems [1]. Increasing abundance of plant species with rapid resource acquisition thus appears as a general response to intense management in various herbaceous systems.

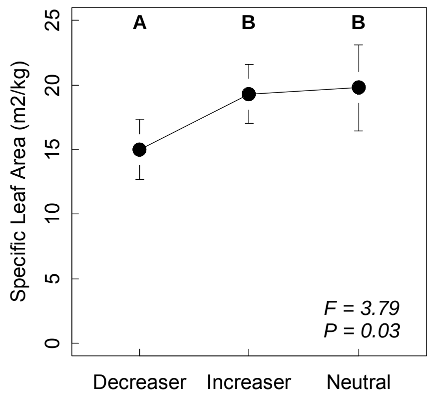

Figure 1: Specific Leaf Area of the response groups to fertilization and sheep grazing.

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Effects of Cattle on Small Vertebrates in Different Habitats in the Simpson Desert, Australia

Anke Frank, Glenda Wardle & Chris Dickman
School of Biological Science, Heydon-Laurence Building A08, The University of Sydney, NSW 2006, email: anke.frank@bio.usyd.edu.au

Arid Australia harbours more than half of Australia's threatened fauna with one third of its terrestrial mammals already extinct[1]. Some losses have been attributed to the effects of lifestock grazing[2].

Spinifex (*Triodia basedowii*) grasslands constitute one of the major biomes of Australia and contain the richest known assemblages of insectivorous mammals[3] and lizards[4] of all the world's deserts. Gidgee (*Acacia georginae*) woodlands have been little studied, but could be an important habitat for native species as well as for cattle by providing drought fodder, minerals and shade.

Beginning in February 2006, vertebrates have been live-trapped in pitfalls to quantify the effects of cattle grazing on their diversity and abundance. Abundance of cattle was measured by dung counts along three walking transects on each one hectare trapping grid.

After flooding rains at the end of a drought in summer 2006/2007 the abundance and species richness of mammals and reptiles increased significantly, but dropped back to before rainfall levels first in areas, which have experienced historically high grazing pressure. Grazing intensity in the past seems to be more important for small mammal diversity and abundance than the removal of cattle in the present.

Cattle prefer the shade and shelter provided by gidgee woodlands to the open spinifex grasslands. Small mammals and reptile diversity was higher in ungrazed than grazed gidgee, but the abundance of mammals and reptiles was more affected by rainfall than by cattle.

We speculate that gidgee woodland patches are important for cattle to meet their food and shelter requirements. These patches also seem to provide an important habitat for mammals and reptiles. Therefore we suggest that these woodlands should be foci for protection and sustainable land management.

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Poster presentations

Rain-Use Efficiency in semi-arid rangelands: Impact of grazing and rainfall on primary production in Southern Morocco

Julian Brenner, Gisela Baumann, Anja Linstädter
University of Cologne, Botanical Institute, Gyrhofstr. 15, 50931 Köln

Water is a primary resource limiting biological activity [1], particularly in arid and semi-arid regions [2]. On rangelands grazing pressure is another important driving force for plant productivity (ANPP). Rain-use efficiency (RUE) is the quotient of annual dry matter production per mean annual precipitation. It indicates the rate in which vegetation converts rain into biomass and has been introduced as an indicator for the productivity of ecosystems which allows to compare between arid and semi-arid ecosystems in different climatic zones [3]. The deviation of RUE from a normal range may be used as indicator for regional degradation [4].

To assess the impact of grazing on RUE, it is compared for two pastures in the High Atlas region, Morocco, along precipitation and grazing gradients.

At one-year grazing exclosures the ANPP and RUE show a peak whereas control and seven-year ungrazed plots show lower ANPP and RUE. Results can be explained by the plants' limited ability to take-up water at low availability. Intraseasonal variability has more pronounced effects at the lower end of the precipitation gradient and on more severly grazed plots.

This matches results that increasing grazing pressure leads to an increased variability of ANPP and RUE. This has important consequences for natural resource management in semi-arid rangelands.

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Over-utilisation of communal rangeland: effects on the soil seed bank and limitations for *veld* regeneration

Niels Dreber
BIOTA Southern Africa, University of Hamburg, Biocentre Klein Flottbek & Botanical Garden, Ohnhorststrasse 18, 22609 Hamburg, Germany

A crucial problem in arid Namibia is land degradation due to a non-sustainable management of land resources. Especially communal rangelands are highly affected by intensive small stock-farming. Increasing bare ground, loss of phytodiversity and shifts in plant species composition towards annual, less palatable species can be observed as signs of rangeland degradation around many rural settlements. To evaluate to what extent a degraded vegetation state is reversible and to find appropriate restoration methods, not only above ground vegetation data should be considered. Concerning this matter the analysis of the soil seed bank gives a more comprehensive picture of biodiversity in space and provides information on the recovery potential of the vegetation towards more desirable conditions.

A case study investigating the effects of contrasting land tenures on the soil seed bank of shrub-savanna vegetation is conducted in southern Namibia. The study aims (1) to understand general patterns in the spatial distribution, species composition and seed densities of the soil seed bank under differing grazing regimes as well as (2) to gather information on the reversibility of vegetation degradation and the regeneration potential of degraded habitats, respectively. The study sites are adjacent and located on a governmental research farm and a neighboring communal rangeland. A marked fence-line contrast reveals the impacts of decades of heavy grazing on the communal site as opposed to restricted grazing on the research farm. A total of 1200 soil cores were collected for germination experiments on the rangelands under special consideration of bare patches and safe sites for seed retention and accumulation.

First results prove below ground rangeland degradation on the heavily utilized communal land and indicate strong limitations in the regeneration capacity contrary to the adjacent less grazed rangeland. The species composition of both seed banks is similar to the above ground vegetation and comparing the rangelands have some species in common. However, the seed bank of the communal land shows a reduced growth form spectrum and a shift towards a dominance of short-lived, generalist plant species. Two annual plant species only account for nearly 70% of the total germinable seed bank. Although the soil seed bank of safe sites provides a seed pool for rangeland regeneration –as indicated by highest species numbers and seed densities found- it lacks valuable plant species. Thus, the seed supply of desirable species is insufficient (e.g. seed loss through intense predation) and/or the possibilities for keeping seeds dispersed from the adjacent rangeland inadequate due to the quality of safe sites. It is concluded that the communal rangeland has lost its ability to recover towards more desirable conditions and active restoration methods only may lead to an improvement of the rangeland.

Why are coastal dunes so important for the survival of the Niobe fritillary (*Argynnis niobe*) in central Europe?

Thomas Fartmann (1) & Alexander Salz (2)
(1) Institute of Landscape Ecology, Department of Community Ecology, University of Münster, Robert-Koch-Str. 26, D-48149 Münster, email: fartmann@uni-muenster.de
(2) Gronauweg 23, 48161 Münster, phone: +49-251-8712534, email: Alexander.Salz@web.de

The Niobe fritillary (*Argynnis niobe*) has suffered a dramatic decline throughout central Europe in the last decades. Besides the Bavarian Alps and the southern parts of the Black Forest the east Frisian Islands are the last remaining strongholds of *Argynnis niobe* in Germany. Although, the species is considered endangered, little is known about the reasons for the observed decline. Therefore we studied the oviposition and larval habitats of *Argynnis niobe* in the dunes of the east Frisian Island Langeoog.

The oviposition and larval habitats of *Argynnis niobe* are characterized by a warm microclimate. Immature stages of *Argynnis niobe* prefer low-growing vegetation with bare ground and a good exposure to the sun. Of the two common *Viola* species in the grey dune vegetation, *Argynnis niobe* prefers *Viola canina*. Leaf break of *Viola canina* is well synchronised with hatching of *A. niobe* larvae. Moreover, the leaves of *Viola canina* showed a narrower C/N ratio than those of *Viola tricolor* ssp. *curtisii*, thus representing a better food quality.

Vast areas with potential habitats for the immature stages are essential for long time survival of *A. niobe*. Distribution data from the Wadden sea islands show that *A. niobe* populations only occur on islands with at least 100 ha of grey dune vegetation.

Natural recovery capability of gypsophilous vegetation in abandoned croplands in semiarid central Spain

Esmeralda Martínez-Duro (1), Pablo Ferrandis (1), José M. Herranz &José A. López-Donate (2)
(1) ETSIA, University of Castilla-La Mancha; Avda. de España, s/n, 02071 Albacete, Spain.
(2) Organismo Autónomo de Espacios Naturales Protegidos de Castilla-La Mancha, Fabrica de Harinas, Paseo de la Cuba 27, Albacete (Spain)

The natural vegetation of gypsum steppes in La Mesa de Ocaña region (Toledo; central Spain) is formed by communities characterised by high richness of local endemisms. The human pressure and the progressive abandonment of agricultural lands within the context of the agricultural European policy, make necessary to monitor the succession towards a complete natural recovery of such particular vegetation. The main goal of this crhonosequence study consists in the evaluation of natural recovery capability of gypsophilous species, and the identification of the main ecological factors determining dynamics patterns. Such information may be highly useful in deciding the level of human intervention required for the community restoration.

The study was carried out in fifty stands with different crop abandonment ages (1-60 years) and controls (no sign of cultivation in the past) Sampling plots sized 50 m^2. The vegetation was sampled on linear transects. Physical and biological variables, such as slope, herbivory pressure, agricultural practises in the past, and several soil parameters, (e.g., magnesium, organic matter, pH, C:N ratio), were measured as well and classified in four factor groups (age, geography, soil chemical composition and soil physical features). We also calculated biodiversity indexes (richness, cover, evenness) for functional plant groups. We explored the relationship of environmental-factor groups with (a) biodiversity indexes by using Generalized Linear Models (GLMs), and with (b) the vegetation composition by means of Canonical Correspondence Analyses (CCAs).

First results show that abandonment age explains an important percentage (30-10%) of the variability found in every richness index (especially gypsophilous and gypsophyte richness) and in gypsophyte cover. Age is the most explicative factor, together with some of the chemical features, mainly active lime, C:N ratio, nitrogen and magnesium, in all GLMs, even in CCA. This indicates that the gypsophilous vegetation recovery is very slow and takes a lot of time to return to their original composition and cover. Old-fields tend to be dominated by non-native annual species in early succession and gypsophyte species appear in late succession. Chemical features contribute to make the recovery slower or quicker, while other physical and geographical factors are less important to explain the heterogeneity found in vegetation composition, richness and covers.

Some management recommendations required for the community restoration will be presented.

The effects of planting density on grain yield and other agronomical characteristics of Rainfed Chickpea (*Cicer arietinum L.*)

Keyvan Shamsi (1), Sohil Kobraee (2), Hamid Mehrpanah (2)
(1) Islamic Azad University.kermanshah Branch.Iran and ph.D student of Yerevan State University.Armenia
(2) Islamic Azad University.kermanshah Branch.Iran and ph.D student of Agrarian State University.Armenia
Contact information : Keyvan shamsi. Department of Agronomy. Islamic Azad university. Pobox 67155-1774. Baghe nai street. Kermanshah. Iran Phone : 98-831-8247901 Fax : 98-831-8237775, Email : shams 2_K@yahoo.com

A field experiment was conducted to evaluate effects of planting density and variety on the trend of grain filling; yield and yield component to chick pea. The present research was conducted at experimental farm of Mahydasht (Kermanshah). The factorial experiment was designed based on complete randomized block desigen with four replication. In this experiment; the variety in three level (Jam; ILC- 482 and 12-60 - 31) and the planting density in three level (19 , 28 and 57 plant.m^{-2}) were considered. The trend of grain filling, yield component and agronomic characteristics : as some biomass yield; harvest index; number of pods per plant. Number of grain per plant; number of node per main stem; plant height, number of branch per plant; weight of 100 grain; distance between 1st pod to soil; distance between 1st branch to soil and phonological stages the chick pea varieties based on photo growing degree day (PHOTO GDD) Were calculated. The result achieved showed that the maximum speed of grain filling related to density of 28 plant. m^{-2} and ILC-482 variety. Grain yield; number of pods per plant; number of grain per plant; weight of 100 grain; plant height; distance between 1st pod to soil and distance between 1st branch to soil were significantly affected by variety and density but number of branch per plant was affected by density and number of node per main stem and harvest index were affected by variety. The maximum photo growing degree day Ralated to 12-60-31 variety and the maximum grain yield related to density of 28 Plant. m^{-2}.

Relevé-based plant biodiversity maps - a dry land's perspective from southern Mongolia

Henrik von Wehrden (1,2), Jan Hanspach (3), & Karsten Wesche (1,4)
(1) Martin-Luther-University Halle-Wittenberg, Institute of Biology - Geobotany and Botanical Garden, Am Kirchtor 1, 06108 Halle/Saale, Germany, E-mail: HenrikvonWehrden@web.de
(2) Research Institute of Wildlife Ecology, Savoyen Strasse 1, Vienna, 1160 Austria
(3) UFZ Helmholtz-Centre for Environmental Research, Theodor-Lieser-Str. 4, 06120 Halle, Germany
(4) University of Göttingen, Albrecht-von-Haller-Institute for Plant Sciences, Dep. of Ecology and Ecosystem Research, Untere Karspüle 2, 37073 Göttingen, Germany

Southern Mongolia is a vast arid ecosystem where large Protected Areas (PAs) have been established in recent decades. In this light, for this study we tried to predict plant biodiversity as a key variable in the nature conservation of these regions based on 1263 relevés of the zonal vegetation. We used standard climatic variables derived from the worldclim database as predictors; we also implemented a high resolution digital elevation model (SRTM data) and a remote sensing productivity layer (mean GLOPEM data 1981-1999). In order to reduce the redundancy of these predictors we initially performed a PCA of the complete set of continuous predictors.

Using our relevés we produced vegetation maps for all southern Mongolian PAs and their surrounding buffer zones based on supervised classifications of Landsat data. We deliberately excluded non-zonal vegetation units since these show a low climatic dependence and a high variability in plant biodiversity. We then performed an ANCOVA of the first three PCA axes of the continuous data in interaction with the data on vegetation units derived from the vegetation maps. Models were calculated for two hierarchical levels, namely the classes and the associations of the vegetation.

The ANCOVA performed superior compared to the results of a linear model calculated without the vegetation types. We quantified autocorrelation by calculating a correlogram of the residuals of both models based on Moran's I, but no significant autocorrelation was detected. In this arid ecosystem plant biodiversity is mainly driven by precipitation, which largely corresponds to productivity and shows pronounced altitudinal gradients. Our sampling accounted for the extrinsic autocorrelation of the ecosystem. Since all predictors and the vegetation maps were available as spatial data we employed the final ANCOVA models in order to produce maps of the plant biodiversity of each protected area. Taken together, these maps covered a range of ~100000 km^2 (Gobi Gurvan Saykhan National Park; Great Gobi Strictly Protected Areas; Small Gobi Strictly Protected Area).

We suggest that spatial predictions derived from relevé-based plant biodiversity can be improved by incorporating vegetation maps into the models. In vast ecosystems such as those of southern Mongolian this approach should help to facilitate the generation of continuous data layers, as well as help to provide baseline data for effective conservation management.

Land use dynamics and its consequences for biodiversity

2.3. Effects of bioenergy production on biodiversity: Local to global case studies and scenarios

Cancelled

Land use dynamics and its consequences for biodiversity

2.4. Riverine landsapes: Key ecosystems for linking aquatic and terrestrial biodiversity

Christiane Ilg, Leonard Sandin, Klement Tockner, Piet Verdonschot

Oral presentations

Organisation of aquatic and terrestrial biodiversity in riverine networks

Klement Tockner (1), Christiane Ilg (2), Leonard Sandin (3) & Piet Verdonschot (4)
(1) Leibniz Inst Freshwater Ecol & Inland Fisheries, Muggelseedamm 301, D-12587 Berlin, Germany
(2) UFZ, Helmoltz Centre for Environmental Research; Department of Biological Conservation, Permoserstr. 15, 04318 Leipzig, Germany
(3) Swedish University of Agricultural Sciences, P.O. Box 7050, 750 07 Uppsala, Sweden
(4) Alterra, Green World Research, P.O. Box 47, 6700 AA Wageningen, The Netherlands

Riverine networks can be considered as hierarchically structured metaecosystems where aquatic and riparian ecosystem types, and their individual habitats, are spatially and temporally interconnected by the flow of energy, material, and organisms. However, there is a major lack in understanding the hierarchical organisation of communities within these networks and the functional linkages among the various ecosystem and habitat types. Here, we focus on four key aspects of riverine biodiversity: First, we discuss the hierarchical organisation of aquatic and terrestrial biodiversity in a riverine network, and how overall biodiversity (gamma diversity) depends on the relative composition and the configuration of the network system. Second, we emphasise the functional linkages between aquatic and terrestrial communities. Third, we highlight the role of refugia as sink-source habitats. The availability of refugia depends on river style and on the type and extent of a disturbance event. Fourth, we present a conceptual framework on the functional linkages among habitat and ecosystem types through the dispersal of aquatic and terrestrial organisms. We postulate that riverine networks are highly efficient transfer corridors even for weak dispersers such as springtails, snails, or small mammals. Understanding riverine networks as metaecosystems is a prerequisite for the development of successful conservation and restoration measures.

Carbon fluxes in the Amazon basin – A modelling approach to understand the complex interactions

Fanny Langerwisch, Stefanie Rost, Ben Poulter, Heike Zimmermann-Timm & Wolfgang Cramer
Potsdam Institute for Climate Impact Research (PIK), Telegraphenberg A 31, 14473 Potsdam, Germany

The Amazon has one of the largest catchments in the world and plays a vital role for global water and carbon cycles. In Amazonia land use change and climate change are expected to alter the carbon fluxes. This will have global impacts.

In our project we focus on the interaction between land and river. During annual flooding the terrestrial and riverine components of the Amazon basin are closely connected and an intense exchange of organic material occurs. To estimate the amount of transported and transformed carbon under various land use and climate change scenarios we use the dynamic global vegetation and water balance model LPJmL. This biosphere model is representing key ecosystem processes in a realistic manner.

For our purpose we adjusted the hydrology module of LPJmL and provided a framework for a new module that links terrestrial processes with riverine fluxes.

First we adapted our model to the specific characteristics of the Amazon basin. We developed a heterogeneous flow velocity to improve the reproduction of the temporal flood pattern. Additionally we included the information of the flood plain area to the model to represent the spatial pattern for land-river-interaction. Finally we developed a simple model for the biochemical cycling of organic carbon through the river system.

The aim of our study is to understand the complex interplay occurring in a flood plain and the effect of land use and climate change on these interactions.

Recognition of ecosystems services as a part of water and land management in the Tisza River Basin

Elena Livia Minca, Katalin Petz, Rik Leemans & Saskia Werners
Wageningen University and Research Centre, Costerweg 50, Building no. 400, 6701 BH Wageningen, The Netherlands

Providing ecosystem services – the benefits people obtain from ecosystems – is strongly dependent on the capacity of natural processes and ecosystem functioning. The inclusion of ecosystem services in spatial and policy planning is important, since the services are highly influenced by climatic conditions, water management and the institutional context. In Hungary and Romania the required scientific research for the consideration of ecosystem services in spatial planning and in the institutional context is weak. The Tisza River Basin, which is shared by these two countries, is increasingly facing the impacts of floods and droughts. In order to mitigate their effects and to sustain human well-being an integrated approach combining transboundary water and land management and the institutional context is needed. The ecosystem service perspective can provide such an approach..

This symposium aims at discussing the role of ecosystems services and their importance in two cases of the Tisza River Basin by presenting an assessment of ecosystems services in the context of land and water management schemes, policy framework and climate related extremes. The two cases are both pilot areas for new water and land management plans: (1) the Hungarian Bereg Region, where future flood-retention polder plans have been developed under the European Bereg-INTERREG Neighborhood Programme; (2) the Romanian Crişul Negru Basin where the creation of wet areas along the Crişul Negru River has been proposed by the Ministry of Environment. Fourteen ecosystem services are investigated for the following land cover types: arable land, grassland, forest, orchard, wetland, water body and urban environment. The analysis is done for the plot, landscape and watershed spatial scales.

In this symposium a specific framework will be presented focusing on the performance of ecosystem services and the factors that change it. They are: state of ecosystems, weather extremes, recognition, potential, policy measures and water management plans. Firstly, the link between ecosystems services and water and land management will be discussed. Secondly, the expression of ecosystem services in relevant European and national policy acts will be pointed out. The approach follows the similarities and differences between the two countries. Our contribution to the symposium will highlight the importance of ecosystem services and their consideration, both related to the policy context, weather extremes and water management plans in a transboundary context. The discussion will focus on how an integrated ecosystem services assessment can contribute to decision making and planning.

Evaluating alternative land use options in rural floodplains

James Rouquette (1), David Gowing (1), Graham Tucker (2), Helena Posthumus (3), Quentin Dawson (3), Tim Hess (3) & Joe Morris (3)
(1) Department of Life Sciences, The Open University, Walton Hall, Milton Keynes, MK7 6AA, UK
(2) Ecological Solutions, 5 Rosenthal Terrace, Hemingford Grey, Huntingdon, PE28 9BL, UK
(3) Department of Natural Resources, School of Applied Sciences, Cranfield University, Bedfordshire, MK43 0AL, UK

Agricultural flood defence schemes in floodplain and coastal areas were once an important element of government support for farmers in Britain and elsewhere in Europe. More recently, however, changing priorities in the countryside, concern about environmental quality and perceptions of increased flood risk in lowland areas, in part linked to climate change, have promoted a re-appraisal of land management options and policies for floodplain areas. By combining the perspectives of natural and social sciences, the consequences for agricultural production, farm livelihoods, nature conservation, and the management of flood risk can be assessed, which can inform future decisions on sustainable management.

Eight agricultural flood defence schemes from different parts of England were selected for study. Information was collected on the current biodiversity present at each site by conducting survey work, and collating secondary data from a variety of sources. Other methods utilised during the research project have included farmer interviews, hydrological modelling, and stakeholder and institutional analysis.

Integration has been achieved through scenario analysis and ecosystem assessment. Six scenarios have been modelled, representing divergent future goals, representing the prioritization of various aspects of agricultural production, biodiversity conservation, or flood storage capacity. Each scenario has been assessed with respect to its effect on ecosystem services and areas of potential conflict and synergy have been identified.

This talk will focus on the challenges and results of the biodiversity assessment and the integrated analysis of ecosystem services. The outcomes will be illustrated with reference to one of our study sites, Beckingham Marshes on the River Trent.

The role of Austrian floodplains for the survival of species of high conservation priority

Klaus Peter Zulka
Umweltbundesamt, Department of Biodiversity and Nature Conservation; Spittelauer Lände 5,A-1090 Vienna, Austria

For a long time, species conservation has been dedicated to a large part to charismatic large, popular and well-known species. In the light of the 2010-target to stop biodiversity losses, species conservation must refocus towards conservation-dependent and endangered species.

The updated Red Lists of threatened Austrian animals provided the background and a major data source for a system of six criteria to rank species according to their conservation priority. These criteria were (1) Red List threat status, (2) national responsibility, (3) international threat status, (4) abundance trend, (5) umbrella potential and (6) need for action. Species were ranked for each criterion and an overall score was obtained by averaging the ranks. Then, the 50 top-priority vertebrates were clustered according to habitat preferences, major threats and potential conservation strategies.

Of these 50 species, 21 were associated with wetlands in a wider sense, of which four species were highly dependent on river landscapes, in particular the Danube and Morava floodplains of Eastern Austria, namely mudminnow (*Umbra krameri*), European pond terrapin (*Emys orbicularis*), Danube crested newt (*Triturus dobrogicus*), and European weatherfish (*Misgurnus fossilis*). These species use floodplain waters of a particular developmental stage and disturbance frequency. Reconnection of floodplain side channels to the main channel, a major restoration strategy in the Austrian Alluvial National Park, may expose these species to competitors and lead to extinction of the remaining populations. On the other hand, ground water level decrease and decoupling of floodplain waters from channel hydrodynamics may lead to overgrowth and a complete habitat loss in the long run. Implications of several floodplain conservation strategies and habitat restoration options are discussed with regard to the protection of floodplain species of high conservation priority.

How to support riparian species? Impact of groyne form on the habitat availability for *Bembidion velox* (Col., Carabidae)

Meike Kleinwächter
Technical University Braunschweig, Institute of Geoecology, Langer Kamp 19c, 38106 Braunschweig, Germany

On a global scale, river banks have a specific terrestrial invertebrate fauna [1]. In Europe and North America, however, riparian zones of almost all large rivers have been severely modified by river engineering and alterations of the natural flow regime. Hence, the riparian fauna is generally vulnerable or threatened and a large number of the species are red-listed. Today, suitable measures are required to induce hydro-morphological dynamics and support the development of riverine biotopes and the recovery of adapted species.

To achieve this goal a new groyne type was built at the River Elbe in Germany. While the standard inclined construction reduces the hydro-morphological dynamics within the groyne fields, which leads to a long-term siltation process, the new type promotes erosion processes by means of a recess at the bank side of the groyne. In order to assess if groyne modification is an appropriate approach to support riparian species, the ground beetle *Bembidion velox* (L., 1761) was chosen as target species and has been studied since 2000. The main objectives are: (1) to obtain knowledge of the impact of hydro-morphological processes on the species population development and (2) to develop a prediction tool for the geo-morphological and ecological consequences of the groyne modification on their spatial and temporal scale.

Habitat analysis and laboratory experiments with immature stages show that the population development of *B. velox* is not only adapted to but also dependent on hydro-morphological processes. High sand content, sparse vegetation and proximity to the water line are the key habitat factors for successful offspring performance. Based on these findings the habitat availability for *B. velox* was simulated with digital maps considering different discharges and groynes forms. Results show that modifications of the regular groyne form can form scours and small sand banks, which lead to an extension of the shoreline and increase the habitat availability for *B. velox*. The high number of groynes along the River Elbe and other rivers require constant restoration and maintenance, which gives an opportunity to build new groyne types instead of reconstructing the old ones and to considerably improve habitat diversity and connectivity.

[1] Andersen, J. & Hanssen, O. (2005) Riparian beetles, a unique, but vulnerable element in the fauna of Fennoscandia. Biodiv. Conserv. 14, 3497–3524

Ground beetle trait variation along a flood disturbance gradient

Michael Gerisch & Christiane Ilg
Helmholtz Centre for Environmental Research – UFZ, Dept. Conservation Biology, Permoser Str. 15, 04318 Leipzig, Germany
michael.gerisch@ufz.de, christiane.ilg@ufz.de

Hydrological disturbances such as floods are an integral component of functioning floodplain ecosystems. These habitats feature highly diverse and spatially distinct invertebrate communities differently adapted to varying hydrological conditions. Relating species traits with hydrological disturbance parameters can provide important insights in the function and distribution of riparian invertebrate communities. Here we present data from Elbe River grasslands (Germany) on the distribution of ground beetle abundance & diversity as well as mobility and development strategy traits along a flood disturbance gradient. The gradient is based on factorial scores of a principal component analysis (PCA) combining flood duration, maximum flood height and flood frequency. We used regression analysis to reveal the relationships between the flood disturbance and species number & density, species diversity and trait variation.

Both, ground beetle species and traits showed a strong orientation along a flood disturbance gradient. Species number, species density and species diversity significantly increased with increasing flood disturbance. High hydrological disturbances are related with a high proportion of small and macropterous species overwintering as imago. In contrast, low flood disturbance favors bigger species with a rather low mobility and larval overwintering. This may indicate that effective resistance to flood disturbance is purchased by venturous overwintering with high demands on adult fitness. The results are further discussed in the context of biological adaptation strategies and support the use of biological traits for biomonitoring and hydrological impact predictions.

Biodiversity at the aquatic-terrestrial interface of the River Elbe

Xavier-Francois Garcia & Martin Pusch
Leibniz-Institute of Freshwater Ecology and Inland Fisheries, Berlin, Mueggelseedamm 301, 12587 Berlin, Germany. Tel.: +49-30-64181685, Email: garcia@igb-berlin.de

Aquatic invertebrate diversity in rivers has mostly been studied separately for the river channels and the standing waters present in the flood plain. Hence, integrative analyses of aquatic invertebrate diversity across the aquatic-terrestrial interface in rivers are rare. However, there are indications that biodiversity at the aquatic-terrestrial interface might significantly contribute to the overall biodiversity of the river. In that case, the assessment of the ecological status of rivers could be potentially improved by considering key habitats located at the aquatic-terrestrial interface, especially for the distinction between the 'very good' and 'good' status.

Hence, we compared invertebrate assemblages in lotic habitats, temporary pools accompanying the river channel, and perennial small ponds in the flood plain. This comparison was conducted in 2003 on two sections of the River Elbe, near the cities of Wittenberg and Havelberg. In the river, two sites were investigated with three replicates each, a standard stretch of river shore modified by the construction of standard stony groynes perpendicularly positioned to the main channel axis, and an alternative mode of shore protection constituted by a 800 m long stony groyne positioned parallel to the main channel axis, in such a way that water can flow between the bank and the groyne. An intermediate morphological status of river shores was encountered between groynes which were partially destroyed by the river, so that gaps were created in the groynes which allowed the river water to flow from one groyne field to another. In the floodplain, two former side channels with different degrees of connection to the main channel were investigated with three replicates each too. We hypothesized that these hydromorphological differences would support faunistic gradients from the main river channel to the flood plain.

Results showed that perennial ponds harbour the most specific and diverse invertebrate assemblages as well as the highest productivity, while standard perpendicular groyne fields exhibit the lowest productivity, the lowest species richness and do not include habitat-specific taxa. When connected to the main channel (wet phase), shore areas related to destroyed and parallel groynes exhibit species assemblages similar to those of the standard groyne fields. Conversely, during the pool phase, temporary pools in shore areas related to destroyed and parallel groynes exhibit a high number of habitat-specific taxa, mainly characterised by early colonisers. Thus, temporary pools constitute a hot spot of productivity and diversity for the river. However, the shore area behind the parallel groyne nevertheless exhibited a higher diversity when connected with the Elbe. Standard groynes appear to be more sensitive to the invasion by neozoa than any other site-types.

In conclusion, faunistic gradients could be observed from the main river channel to the floodplain. These gradients were related to a gradient of decreasing hydrodynamics and increasing microhabitat heterogeneity (temporary pools vs perennial ponds). Fluvial structures located at the aquatic-terrestrial interface, like the temporary pools, appeared to constitute key habitats, which significantly contribute to the overall biodiversity of the River Elbe, especially considering its mostly modified shoreline.

In-channel and bank hydromorphological features and aquatic invertebrates biodiversity in temporary rivers of Sardinia

Andrea Buffagni, David G. Armanini, Daniele Demartini & Stefania Erba
CNR – IRSA, Water Research Institute, Via della Mornera, 25, 20047 Brugherio (MI), Italy

At the largest spatial and temporal scale, biogeographical constrains determine the list of aquatic taxa that can be found at a river site. Such restrains are usually stronger for island communities, where endemic species – invaluable for global biodiversity - can be a relevant proportion of the total community. Once evolutionary trends and species distribution are fixed, habitat structure and variety at a range of spatial scales make a river site suitable or not for aquatic species. In general terms, both aquatic and riparian habitats can be highly relevant in determining the overall biological diversity in rivers. Even if in all river categories floodplain and bank habitats interact with in-channel and aquatic habitats, in temporary rivers such interactions can become primary in determining species presence and richness.

The main aim of the paper is to investigate which hydro-morphological and/or land-use features of a river site are relevant for aquatic invertebrate richness and abundance in a large mediterranean island, with special focus on endemic or rare Ephemeroptera species.

Invertebrate data were collected with multi-habitat, proportional sampling and the hydromorphological information was gained by applying the CARAVAGGIO method (river habitat survey technique) in the field. The used dataset was generated from high or good ecological status sites located in temporary rivers in Sardinia (Italy).

Richness indicators and the presence/abundance of Ephemeroptera species were related to a set of environmental and habitat variables, which include catchment-scale parameters, reach characteristics, meso-scale factors and chemical indicators.

As far as habitat and hydromorphological features are concerned, the following four river sectors were considered: submerged, in-channel (non-aquatic), riparian, laterally from each banktop. The relationships between key hydromorphological and land-use features of rivers and selected biological metrics linked to taxon richness and abundance of rare/endemic Ephemeroptera species were investigated by means of Partial Least Squares regression (PLS) analysis.

Landuse dynamics at the regional and local scale and its consequences for biodiversity in streams

Leonard Sandin
Swedish University of Agricultural Sciences, Department of Aquatic Sciences and Assessment, P.O. Box 7050, SE-750 07 Uppsala, Sweden

Running waters are vulnerable ecosystems under increasing pressure from anthropogenic factors such as habitat alteration through e.g. changes in hydrology and modifications of the riparian corridor. The alteration in habitat structure can be affected by larger-scale variables such as land-use change, since processes in running water ecosystems are strongly influenced by the surrounding areas at multiple spatial scales. Some of these environmental characteristics such as hydrology and channel characteristics are more influenced by landscape features and catchment land use whereas in-stream habitat structure and organic input are more structured by local conditions such as near-stream land-use. At the same time a change in climate will in the future affect land-use in the catchment and riparian zone (through either intensification or withdrawal of e.g. agriculture) affecting stream hydromorphology through changes in hydrology, habitat composition and habitat availability.

In this paper I will examine the effects of land-use and land-use dynamics both on the catchment scale and the local (riparian zone) scale and its effect on stream and river biota (benthic macroinvertebrates). This will be assessed using data from some 700 streams sampled as part of the Swedish National Stream Survey. The effects of land-use on community composition and biodiversity of benthic macroinvertebrates as well as for ecological status of running waters (important in relation to European water policies such as the EC Water Framework Directive) will be evaluated. The main results comes from the EU funded project Eurolimpacs [http://www.eurolimpacs.ucl.ac.uk/], a project focusing on the evaluation of global change on European freshwater ecosystems.

Additive partitioning and biodiversity patterns on Madeira Island: the case of bryophyte communities from streams

Leena Luís (1,2), Manuela Sim-Sim (1), Rui Figueira (4) & Ariel Bergamini (3)
(1) Lisbon University, Science Faculty, DBV/CBA, Campo Grande, 1749-016 Lisboa, Portugal;
(2) National Museum of Natural History, Botanical Garden, Rua da Escola Politécnica, nº 58, 1250-102 Lisboa;
(3) Swiss Federal Research Institute WSL, CH-8903 Birmensdorf, Switzerland;
(4) Institute of Tropical Scientific Research. Rua da Junqueira, n.º 86 - 1º, 1300-344 Lisboa, Portugal.

The Madeira Archipelago is situated in the Atlantic Ocean and is a part of Macaronesia. Due to its volcanic origin, the relief of the Madeira island (the main island of the Madeira archipelago) is very irregular and various streams are occurring on both the north and the south side of the island.

Here we focus on diversity patterns of ripicolous bryophytes on Madeira island. We studied two related communities: the within-stream community (submerged all year round) and the stream-border community (submerged only in winter). We selected 16 streams (eight streams on the north side of Madeira, and eight on the south side). In each stream we sampled bryophytes in three sections: upstream, at the center, and downstream. Within each section two sites were chosen within which 6 plots were sampled (total n = 576 = 6 plots x 2 sites x 3 sections x 16 streams). To study effects of the main factors on species richness we used ANOVA models. For evaluating which spatial scales were the most important contributors to total species richness, we additively partitioned biodiversity in its alpha and beta components.

We found a total of 178 taxa (16 endemics) in the within-stream community, and 51 taxa (3 endemics) in the stream-border community (34% and 29% of the Madeira bryoflora). For both communities species richness was higher on the north side than on the south side of the island and higher in the upstream sections than in the other sections as revealed by ANOVA. These were the areas which are mainly covered by Laurel forest. Results were very similar for richness of endemic species. Only for effects of the stream section there was a discrepancy: no effect on endemics but a strongly significant effect on total species richness. We identified for both habitats the between river system component as the most important contributor to total island richness. This was also true for the richness of the endemic species. On the stream level, the between section component contributed most to the mean stream level richness.

We conclude that Madeira streams harbour a high number of bryophytes. However, the stream-border community is much richer in species than the within-stream community. This may be due to the higher disturbances that the within-stream bryophtes are subjected to. The high contribution of the stream component to the total species richness is mainly due to the high number of infrequent taxa. As the infrequent taxa are often restricted to distinct streams, each stream adds new taxa. With respect to species conservation, the most important areas have to be delineated and rigorously protected. It was shown that the Laurel forest (a UNESCO world heritage community) is also a hotspot of ripicolous bryophyte diversity, emphasizing once more the importance of this area in the conservation of biodiversity on Madeira Island.

Restoring plant biodiversity in riverine grasslands of Central Germany

Armin Bischoff (1), Guido Warthemann (2) & Nadja Winter (3)
*(1) University of Halle, Institute of Biology/Geobotany, Am Kirchtor 1, D-06108 Halle, Germany**
(2) LPR Landschaftsplanung Dr. Reichhoff GbR, Zur Großen Halle 15, D-06844 Dessau, Germany
(3) Hochschule Anhalt (FH), Fachbereich 1 (LOEL), Strenzfelder Allee 28, D-06406 Bernburg, Germany

The loss of plant diversity in floodplain grasslands along Saale and Elbe river has been well documented in conservation literature. The decline is predominantly the result of land use changes, hydrological factors are of minor importance. Particularly, the intensification of grassland management including conversion to arable use during the 1970s and 1980s has contributed to this development. Following the political change and subsequent integration of the former GDR into EU Common Agricultural Policy (CAP), agri-environmental schemes were implemented at the beginning of the 1990s to restore original species richness of riverine grasslands. These schemes have only been successful where remnant populations of target species had survived the period of intensive management. Dispersal limitation and low establishment rates in the dense grassland swards have prevented the re-colonisation at many sites.

We initiated a long-term study to quantify the speed of colonisation processes in floodplains. We established transects from remnant species-rich target communities into restoration sites that had been re-converted from intensive management after 1989, and we observed subsequent changes in target species abundance along transects. Additionally, we started an experiment to test the efficiency of hay transfer methods in artificially introducing target species at restoration sites. Seed transfer rates were analysed by examining seed densities at the source sites and counting transferred seeds in seed traps at the restoration sites. Three soil cultivation treatments (ploughing, harrowing, undisturbed) were applied to analyse the importance of soil disturbance for seedling emergence and establishment.

Table 1: Mean densities (m^{-2}) of two target species at restoration sites (15 m from target communities); different letters indicate significant differences between the years based on Tukey HSD Posthoc tests

	1998	1999	2000	2001	2002	2003	Target community
Silaum silaus	0.012[a]	0.037[ab]	0.048[ab]	0.126[bc]	0.168[c]	0.161[c]	3,19-5,11
Serratula tinctoria	0.007[a]	0.005[a]	0.011[ab]	0.016[ab]	0.013[ab]	0.024[b]	1,32-2,19

Please check table format

The transect analysis showed a slow colonisation of restoration sites from adjacent species-rich reference communities with large populations of target species (Table 1). The increase in population density was only significant after the third (*Silaum silaus*) and the fifth year (*Serratula tinctoria*) of the study period. Even nineteen years (1989-2008) after re-conversion to traditional management, the density of target species was far below that of adjacent reference grasslands. Hay transfer was found to be an efficient method to overcome dispersal barriers but transfer rates were highly species-specific. Only 15% of *Cnidium dubium* seeds of the source sites were carried to the restoration sites but 86% of the *Sanguisorba officinalis* seeds. Soil disturbance significantly increased seedling emergence, data on seedling establishment are not yet available.

* *Present address: National Institute of Horticulture and Landscape Planning (INH), Department of Biological Sciences, 2, rue André Le Nôtre, 49045 Angers Cedex 1, France*

Rare plants of European river corridors: life strategies between natural environmental conditions and local management

Katja Geißler & Axel Gzik
University of Potsdam, Institute of Biochemistry and Biology; Maulbeerallee 2a, 14469 Potsdam, Germany

Conservation of rare species currently represents a very popular topic in wetland ecology; however, it is not always clear how the environment should be manipulated to increase the abundance of such species. Some plant species are restricted to river corridors [1]. This requires us to think about the mechanisms generating their peculiar distribution pattern.

Here we focus on the widely assumed low competitive ability of these plants and the concluded need for dynamic habitats to survive in the presence of competition. We used three endangered river corridor angiosperms *Cnidium dubium* (Schkuhr) Thell., *Gratiola officinalis* L., and *Juncus atratus* Krocker to test whether their competitive performance is low. In a second step we analysed their specific response to typical dynamic European river wetland conditions, which are created by summer drought and winter/spring flooding as well as extensive management such as mowing. Competition together with summer drought and winter/spring flooding were applied in a 2-year common garden experiment; the mowing treatment was conducted at natural sites.

Our studies have yielded results indicating that the three species are very weak competitors, but they are not unique in their life strategies to adapt to the typical natural river wetland environment. We concluded that habitat conservation in terms of high diversity must be a first priority in overall wetland management.

Other factors, which are considered important in western and central European restoration goals for wetlands are traditional forms of land use. A critical factor in estimating active management strategies for these ecosystems will be the demographic perspective. Here we focus on the characteristic semi-natural grassland plant species *Cnidium dubium*. At ramet level, the most marked effect of extensive mowing was that fewer ramets entered the generative life stage [2]. But interestingly, the individual genets were able to keep their overall reproductive performance on a level independent of mowing, since mowing had no influence on ramet density across different grasslands.

The implications of the presented experimental studies will be discussed in relationship to timing of environmental and/or management changes.

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The effect of the extreme summer flood on the species composition and life history traits – the example river Elbe

Judith Glaeser
Helmholtz Centre for Environmental Research – UFZ, Dept. Conservation Biology, Permoser Str. 15, 04318 Leipzig, Germany

The composition of plant species in floodplain meadows is affected by frequency, duration and the depth of inundations as well as the groundwater regime. The occurrence of species along the floodplain moisture gradient is very strongly correlated with the flooding tolerance of species. Furthermore, species zonation in floodplains seems largely influenced by severe but rare flooding events in the growing season, even thought most floods generally occur during the winter period in temperate areas.

In 1998/99, grasslands of the river Elbe, with shorter and longer duration of inundations and oxbow channels were investigated. In 2002, a summer flood took place which was untypical in time and intensity. From 2003 to 2006 the same vegetation plots as in 1998/99 were investigated with identical sampling methods.

The aim of the study was to investigate the effects of an extreme summer flood event on the plant species composition and life history traits of floodplain grasslands with different moisture levels.

The composition of plant species in the wet floodplain areas was weakly influenced by the summer flood. In contrast, the compositions of plant species in oxbow channels and dry floodplain areas were significantly different in the post-flood years compared to the pre-flood years. The differences between post- and pre-flood years were mainly caused by changes the abundance of plant species, even though elimination or immigration of species could not be demonstrated. In the oxbow channels, competitive species benefited from the summer flood whereas low-competitive species decreased significantly in their average cover in the post- flood years compared to the pre-flood years.

Sedimentation induced eutrophication in large river floodplains –an obstacle to restoration?

Valentin Klaus, Jörg Sintermann & Norbert Hölzel
Institute of Landscape Ecology, University of Münster, Robert-Koch-Str. 28, D-48149 Münster, Germany
v.klaus@uni-muenster.de

In river floodplains, sediment deposits with a large amount of nutrients cause highly productive conditions. This can be a severe obstacle to the restoration of nutrient limited target communities containing low competitive species. In this study, the nutrient and floristic gradient of floodplain meadows in the Upper Rhine Valley in Germany were examined to assess the prospects for restoration with increasing distance from the main channel. Soil and plant tissue analysis revealed a significant decline in phosphorus concentrations, with increasing distance of our samples from the river Rhine. Extremely high concentrations occurred in close proximity to the main channel with more than 12 mg of CAL-solulable P per 100 g soil. Already at distance of 300m from the main channel P- concentration in the soil dropped to a quarter of this figure. In line with these findings grasslands close to the river showed a floristic depletion with on average less than 12 species 100m2 whereas already in a distance of 300 m the average species richness per plot increased up to 27. Endangered and valuable species appeared already at a distance of 400 m to 500 m to the river. Surprisingly strong eutrophication effects induced by sediment deposits proved to be confined to the close proximity of the main channel within a distance of 200 m whereas the restoration prospects at more distant sites in the floodplain are obviously not hampered by recent nutrient input in the course of flooding.

Diversity of survival strategies in Amazonian floodplains

Pia Parolin
Universität Hamburg, Fachbereich Biologie, Biozentrum Klein Flottbek, Abteilung Systematik der Pflanzen, Ohnhorststr. 18, D-22609 Hamburg; pparolin@botanik.uni-hamburg.de

An excess of water is mostly deleterious to plant health and growth. Not so in Amazonian floodplain forests which grow at the boundary between rivers and upland forests. In no other ecosystem worldwide trees have to tolerate more extreme submergence conditions, but the regularity of the so-called "flood-pulse" of the Amazon river enabled the plants to form adaptations to the regularly recurring long-term deep inundations. In fact, about nine hundred tree species grow there – more flood tolerant tree species than in whole Europe. They are subjected to regular periods of flooding with freshwater which last up to nine months a year, and water columns reach heights exceeding 10 metres. Stress on plants imposed by flooding includes oxygen deprivation, drastic changes in the bioavailability of nutrients and in the concentrations of phytotoxins, increased levels of CO_2, anaerobic decomposition of organic matter, increased solubility of mineral substances, reduction of soil redox potential, and decreases of light intensity.). All these constraints pose especially problems for woody species, organisms which evolved to survive in a terrestrial environment. They are even more vulnerable in the warm growing season which in the tropics lasts the whole year round. In contrast to temperate zones where flooding frequently occurs during winter and plants are in a quiescent state while flooded or submerged, the aquatic phase in the Amazon region occurs in a period in which temperature and light conditions are optimal for plant growth.

These extreme conditions are tolerated because of a large variety of adaptations to flooding, starting at the seed stage with hydrochory and ichthyochory as main means of dispersal, followed by fast germination and high tolerance to complete submergence in seedlings, and ending in a not yet completely apprehended number of adaptations in adult trees, at phenological, physiological, morphological and anatomical levels. Morphological adaptations of the root system comprise hypertrophy of lenticels, formation of adventitious roots, plank-buttressing and stilt rooting, development of aerenchyma, and the deposition of cell wall biopolymers such as suberin and lignin in the root peripheral cell layers. Water loss and gas exchange in the flooding period are effectively reduced by alterations in vegetative phenology and water storage.

Although several studies describe *how* the plants react to submergence, we know very little about *why* they can do so, which physiological, morphological and anatomical adaptations enable survival and growth despite prolonged submergence in darkness. The present review aims at summarizing the current status of knowledge about how trees and seedlings react to submergence in Amazonian floodplains.

Since also these forests, as most wetland ecosystems, are threatened by human overpopulation and overexploitation, the challenge to understand and thus maintain this ecosystem increases every decade. Basic knowledge about growth rhythms and annual wood increase give us the possibility to analyse recruitment strategies and to put up management plans which lead to sustainable management which is not an option but a must in this unique ecosystem.

Poster presentations

Invertebrate community structure of farmland ponds in relation to land use and pond characteristics

Tom De Bie, Frank Van de Meutter, Robby Stoks, Steven Declerck, Luc De Meester & Luc Brendonck
K.U.Leuven, Laboratory of Aquatic Ecology and Evolutionary Biology, Ch. Deberiotstraat 32, 3000 Leuven, Belgium

Freshwater ponds have important landscape functions and are important for regional plant and animal biodiversity. Understanding how such small aquatic ecosystems are altered by agricultural activities is crucial for the development of strategies for their conservation. In the framework of ALARM, we studied farmland ponds in seven European countries. We wanted to assess to what extent the surrounding land use and local factors (e.g. physical and chemical characteristics and morphometric variables) explain the structure and diversity of invertebrate communities. We sampled the zooplankton and macroinvertebrate communities of a total of 72 ponds (with a mean size of 0.05 ha). In each country we examined three or more clusters of three ponds each. A pond cluster contained one pond that was surrounded by intensive land use, one by extensive land use and one that was situated in rather 'pristine' surroundings (Fig. 1).

Figure 1: Example of a cluster of three ponds in a gradient of land use intensity
(left: pristine, middle: extensive, right: intensive).

Our results clearly demonstrated significant associations of land use variables with several measures of ecological pool integrity. Variables related to the turbidity status of ponds were associated with the distribution of land use around the ponds and with the proximity of croplands. The results also showed that zooplankton and macroinvertebrate composition and taxon richness are associated with surrounding land use characteristics. The effects of land use on invertebrates were mainly caused indirectly via their effect on a number of local factors such as the presence of aquatic vegetation (structural diversity) and the concentration of nutrients (productivity), which are known drivers of invertebrate richness and composition. Mainly the direct distance to cropland, irrespective of crop type, appeared to be an important predictor of pond quality, taxon-richness and community composition of invertebrates and not, or to a lesser extent, the proportion of crop land around the pond. Implementing buffer zones around ponds can thus be efficient to maintain clear water and high invertebrate diversity, even in landscapes dominated with crop lands. Although we have not differentiated between different types of crop land, we expect this to be especially true if the agricultural practices exercised at these crop lands are of low or moderate intensity.

Test of the spatial transferability of a bioindicator system for floodplains

Franziska Konjuchow, Klaus Follner & Judith Glaeser
Helmholtz Centre for Environmental Research – UFZ, Dept. Conservation Biology, Permoser Str. 15, 04318 Leipzig, Germany

The alternation cycle of inundation and drought mainly controls the occurrence and survival of species in floodplains. Based on plant abundances a bioindicator system was developed near Dessau in 1999, which indicates the annual duration of inundation and mean groundwater depth during the vegetation period [1]. Even though the time transferability after the extreme flood event in 2002 was shown, the spatial transferability is not demonstrated adequately. Hence, the aim of the study was to test the spatial transferability of this bioindicator system using the example of the Middle Elbe region in 2006.

The study area is located in the Middle Elbe region and consists of the reference area "Schöneberger Wiesen" near Dessau with 36 plots and the test area with 21 plots. All study plots are situated in the active floodplain. The distances between two test plots range from about 1 km to 20 km. The reference plots as well as the test plots differ in agricultural management, elevation in floodplains and plant species composition.

For each single hydrological factor the criterion of spatial transferability is met, if the median difference, which is the indicated minus the measured value, of the test plots with plant data is equal to or lower than the 75%-quartile value of the reference plots.

The test of spatial transferability was successful. Nevertheless, the amplitude of the water level fluctuations and further unknown factors such as anthropogenic influences seem to have the potential to affect the precision of the bioindicator system. Additionally, it could be shown that both agricultural management and plant species composition do not significantly decrease the precision of the bioindicator system.

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Multi-species inference of environmental conditions for riparian arthropod conservation

Kevin Lambeets (1), Martijn L. Vandegehuchte (1), Jean-Pierre Maelfait (2) & Dries Bonte (1,3)
(1) Ghent University, Dep. Biology, Terrestrial Ecology Unit (TEREC), KL Ledeganckstraat 35, 9000 Ghent, Belgium;
(2) Research Institute for Nature and Forest (INBO), Kliniekstraat 25, 1070 Brussels, Belgium;
(3) Würzburg University, Field Station Fabrikschleichach, Glashüttenstrasse 5, 96181 Rauhenebrach, Germany

River banks are naturally disturbed habitats, in which local flood events and the landscape structure are expected to govern riparian species assemblages. Not solely effects of flooding *per se*, but also related changes in vegetation structure will affect species distribution and assemblage structure. By elucidating the relationships between species' distribution, their abundance and the multivariate habitat conditions, insight into conservation strategies to preserve typical riparian species is gained. By means of variable reduction and multiple regression analysis, environmental constraints (channel connectivity, local flooding, landscape composition and vegetation complexity) on the incidence and density of stenotopic riparian arthropods were clarified. Distribution patterns were in agreement with species' ecological requirements. Riparian spiders are expected to go extinct as a result of increased flooding disturbance, but benefited densities of hygrophilic, dispersive species. Increasing vegetation complexity had a positive effect on the latter. Local topographical features and the surrounding landscape composition affected riparian wolf spiders in opposite ways, indicating the importance of a less hostile lateral transition and suitable hibernation sites nearby. Increasing channel connectivity favoured incidence of mobile riparian carabid beetles and a linyphiid spider, yet solely benefited a rare wolf spiders' density. Our analyses show the importance of an evidence-based approach of river management to ensure the maintenance of vulnerable riparian species. River restoration should generate the required variation in environmental conditions (e.g. dynamic processes) on the river bank level and landscape scale to preserve stenotopic riparian arthropods. Hence, accounting for responses of multiple species provides a more complete framework to guide conservation of riparian species.

Taxonomic status of a *Salix* hybrid complex comparing morphological and genetic data

Uta Müller, Eva Mosner, Birgit Ziegenhagen & Ilona Leyer
Philipps-University of Marburg, Faculty of Biology, Conservation Biology, Karl-von-Frisch-Str. 8, D-35032 Marburg, Germany

Floodplains harbouring a high biological diversity nowadays belong to the most threatened ecosystems. Due to flood control measures they have suffered from habitat degeneration or destruction followed by species losses. Restoration projects are therefore regarded as a necessary conservation task including reforestation activities in regularly flooded alluvial plains. For example, riparian woodland has been removed to a large extent. For reforestation purposes willows (*Salix* spec.) play a significant role since, as a natural member of softwood forests, they are adapted to the alternating site conditions. To achieve a species composition as close as possible to the natural conditions, an identification of the taxonomic status species is required. Members of the *Salix alba* - *Salix fragilis* complex including the hybrid *Salix x rubens* have frequently been determined by morphological and genetic characteristics. Since discrepancies occurred, genetic determination techniques had been enhanced. A recently developed new diagnostic marker in the gene *Cyp*73 allows to discriminate willow species, hybrids and introgressed specimen more precisely. Samples of the willow complex have been taken at the river Elbe with the aim of a comparison of morphological and genetic data including the newly developed diagnostic marker *Cyp*73. This should support an unequivocal species determination for conservation work. Morphological detection was based on bud scales. If a high concordance between both results emerges, a fast and cheap morphological determination will suffice as a reliable system. Discrepancies between the two methods would instead demonstrate the need for a genetically based determination.

Diving seedlings: submergence tolerance of *Nectandra amazonum*

Pia Parolin (1) & Danielle Waldhoff (2)
(1) University of Hamburg, Biozentrum Klein Flottbek, Plant Systematics; Ohnhorststr. 18, D-22609 Hamburg; pparolin@botanik.uni-hamburg.de
(2) Institute for Botany, University of Kiel

Nectandra amazonum Nees (Lauraceae, "Louro") is a typical evergreen non-pioneer tree of Central Amazonian floodplain forests. It is characterized by a very high tolerance of prolonged waterlogging and submergence. Adult trees are seldom subjected to submergence, but during the establishment phase the seedlings have to cope with annual periods of submergence of up to 9 months and flooding water columns exceeding 10m.

Most astonishingly, seedlings tolerate more than 4 months of submergence in complete darkness without shedding their leaves. On the contrary, soon after emergence, the photosynthetic activity of the leaves attains pre-flood values.

In the present study, seedlings of *N. amazonum* were analysed both in the field near Manaus / Brazil and in experiments in a greenhouse of the University of Kiel. The seedlings under controlled conditions were experimentally submerged both with and without light.

Anatomical adaptations: roots. Both in the field and under experimental conditions, the completely submerged seedlings produced adventitious roots, which in the experiment grew to a length of 10,5 cm (compared to 37 cm in waterlogged individuals). The seedlings developed lenticels after 13 days of submergence (density of 10-20 % of the flooded stem area), roots with a negative geotropism after 16 days of submergence, and adventitious roots after 19 days of submergence. While waterlogged plants of these species exhibited very few adventitious roots (approx. maximally 5% of the complete root mass), in completely submerged plants adventitious roots added up to 50% of the total root mass.

Anatomical adaptations: leaves. Even in complete darkness *N. amazonum* did not shed leaves under water. On the contrary, new leaf buds were formed under water which allowed leaf expansion as soon as the plants emerged. Under experimental conditions, for 14 weeks their outer appearance was identical to the non-flooded control seedlings, without symptoms of decomposition. Only in the 15th week some leaves became yellow and some were shed. Overall, the submerged seedlings maintained 60% of the initial leaves even in complete darkness.

Photosynthetic reactions. Waterlogged adults and seedlings of *N. amazonum* show increased CO_2 assimilation as compared to non-flooded control plants. Under experimental conditions, after 12 weeks of submersion in light, five minutes after emersion the submerged seedlings had almost the same CO_2 assimilation and Fv/Fm values as the control plants ($P>0.05$).

Discussion. When compared with other common Amazonian floodplain species, *Nectandra amazonum* shows almost no differences between flooded and non-flooded plants in their outer appearance. The sclerophyllous character of the leaves might be an adaptation to withstand total submergence. The comparably high photosynthetic activity which was measured in *Nectandra* 5 min after emersion shows that the physiological function of the leaves is preserved under water. Whether this species is able to photosynthesize under water is not known to date.

Alluvial shrubland biodiversity and biomass along small rivers in the South Subcarpathians (Romania)

Mihaela Pauca-Comanescu, Marilena Onete & Ioana Vicol
Institute of Biology, Romanian Academy, Spl. Independentei, 296, 060031 Bucharest, Romania

<u>Objectives</u>

- identify plant species' presence in, and quantitative contribution to riparian shrublands, less known in the SE Romanian Subcarpathians, using direct methods;
- put in evidence differences resulting from the use of the phytocoenological and plant ecological methods in the study of these shrublands;
- underline characteristics typical to the South Subcarpathians Nature 2000 alluvial habitats, and particularly of the habitat # 3230, in comparison to the North and Central European habitats.

The shrublands primary developed along the two rivers' banks, Prahova and Doftana (tributary of Ialomita River and then of Danube), were located in the hilly segment situated in the Roumanian South Subcarpathians, between 450m and 650m altitude (latitude $45^0$17'16''and 24'' N, longitude $25^0$43'33''and 41'23''E).

The most frequent shrublands were *Salix purpurea*, followed by *Hippophae rhamnoides* and *Myricaria germanica* (rarely), most of them in their natural structure, and occasionally used by inhabitants. The shrublands were spread in the same order also with the altitude in this region. They belonged to the communities *Saponario-Salicetum purpureae* (Br.-Bl.1930) Tschou1946 (included in Romanian Habitats 4418), *Hippophae-Salicetum eleagni* Br.-Bl.et Volk 1940 (included in R4417 and in European Protected Habitats 3240), *Salici purpureae – Myricarietum* Moore 1958 (included in R4415 and in European Protected Habitats 3230). The communities differed in several regards compared the Central European description.

The case studies on each scrubland type found that:

- the **species' richness** was high in all alluvial shrublands, with the highest value in Salicetum (97 species), followed by Myricarietum (87 species) and Hippophaetum (69 species). However, the diversity only of woody plants was the smallest in Myricarietum.

- the **cover** of the shrub layer in the biocoenosis was similar in Salicetum and Hippophaetum (75-80%), but in Myricarietum was up to 50%.

- the **height** of the shrub' layer was:

	Salicetum	Hippophaetum	Myricarietum
Maximum (m)	5.79	3.56	3.07 (very rare value for Romania)
Mean (m)	3.10	1.85	0.90

- the **aboveground biomass** of the shrub' layer was:

Mean (t/ha)	63.6	34.8	6.39

The relative abundance of biomass was the highest in each shrubland for the dominant species, but the second important plant in this respect was Salix purpurea for all the types. The herbaceous biomass has an active dynamics during all four seasons and varies between 360 and 1120d.w.Kg/ha in different shrublands.

Abstract too long/cut
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The ground beetles – linkage elements between riparian and adjacent terrestrial cenoses

Purice Dorina-Marieta
Romanian Academy, Institute of Biology, Spl. Independentei 296, sect. 6, PoBox 56-53, code 060031, Bucharest, Romania

The ground beetle fauna was studied in Western Romania in six mountain areas (four riparian and two adjacent forest habitats) and in three lowland riparian areas (SW Romania). The fauna was collected manually and with pitfall traps, monthly (from May till October), three years in mountain habitats and one year in lowland habitats. The aim of this study was to indentify the structure patterns and the differences of the riparian ground beetle communities from different altitudinal floors and also the differences between the riparian ground beetle commnuities and the terrestrial adjacent ones. The characteristics of the riparian ground beetle communities were analized according to abiotic factors (temperature, humidity, flooding periods) and biotic factors (the food availability and the presence of the potential competitors). The results emphasized obvious differences in ground beetle species composition both in the communities of upland and lowland riparian areas on one side and differences in the proportion of the tipical terrestrial ground beetle species in the riparian communities on the other side. The degree of similarity of the ground beetle communities is low both in mountain and lowland riparian areas. The analysis of the numerical abundances of the ground beetle species according to the food resources and their potential competitors includes comments on the food resources partitioning at the predator invertebrates trophic level. It is also discussed the biomass production of the tipical riparian species versus terrestrial species in the riparian communities. The conclusions of the study are pointed on the heterogeneity of the riparian habitats, on the importance of the terrestrial adjacent areas in maintaining the structural and functional characteristics of the riparian areas and on the position and role of the ground beetles as key elements in the ecosystems structure and functioning in terrestrial-riparian gradient.

Land use changes on an active floodplain on the Upper-Tisza-Region

Katalin Varga (1), Béla Tóthmérész (1) & György Dévai (2)
(1) Department of Ecology, Faculty of Natural Sciences, University of Debrecen, Egyetem tér 1, H-4032 Debrecen, Hungary, varga.kata@yahoo.com
(2) Department of Hydrobiology, Faculty of Natural Sciences, University of Debrecen, Egyetem tér 1, H-4032 Debrecen, Hungary

In Hungary we find hardly any region, which is not modified by human activity. The land use is a very important factor in developing recent vegetation. It is important to know the processes and influence of land use to understand the actual state of vegetation. Research of landscape history makes possible to follow landscape changes in the past. During our research active floodplain on the Upper-Tisza-Region (Foltos-kerti hullámtéröblözet, NE-Hungary) was studied. We analysed the extension of close-to-natural forests and the changes in the structure of arable lands during the studied period [military maps I. (1782-85), II. (1819-1869), III. (1869-1884), 1944, 1985, 1989, 1995, 2000, 2005]. ArcView3.2 and 9.0. promgrams were used during the work. We created a habitat map of the studied area based on the Hungarian National General Habitat Classification System ("Á-NÉR") and Corine Biotops habitat classification system. For each characteristic category additional information was registered during the field work. Our result showed that the landscape changed considerably. Cover of forests and meadows decreased; the extension of arable lands and orchards increased during the studied period. At present economic plantations comprise the majority of forests on the active floodplain.

Biological invasion and dispersal mechanisms

3.1. Biological invasions: towards quantitative risk assessment

Philip Hulme

Oral presentations

Aliens in Antarctica: First results of a unique IPY project

Ad Huiskes (1), Niek Gremmen (1), Dana Bergstrom (2), Kevin Hughes (3), Jennifer Lee (4), Steven Chown (4), Satoshi Imura (5), Megumu Tsujimoto (5), Mark Lebouvier (6), Yves Frenot (7), Frits Steenhuisen (8) & Maaike VanCauwenberghe (9)
(1) Netherlands Institute of Ecology, P.O. Box 140, 4400 AC Yerseke, The Netherlands, a.huiskes@nioo.knaw.nl
gremmen@wxs.nl
(2) Australian Government Antarctic Division, Kingston, Australia, dana.bergstrom@aad.gov.au
(3) British Antarctic Survey, Cambridge, United Kingdom, kehu@bas.ac.uk
(4) Centre of Excellence for Invasion Biology, Stellenbosch University, South Africa, jlee@sun.ac.za, slchown@sun.ac.za
(5) National Institute of Polar Research, Tokyo, Japan, imura@nipr.ac.jp, tsujimoto@nipr.ac.jp
(6) University of Rennes, Rennes, France, marc.lebouvier@univ-rennes1.fr
(7) French Polar Institute Paul-Emile Victor, Plouzané, France, Yves.Frenot@ipev.fr
(8) Oceanwide Expeditions, Vlissingen, The Netherlands, frits@oceanwide-expeditions.com
(9) Belgian Federal Science Policy Office, Antarctic Program, Brussels, Belgium, vcau@belspo.be

The study of non-indigenous organisms in the Antarctic has focused mainly on the ecological effects of species which colonized these regions successfully (animals such as cats, rabbits, reindeer, and rats; angiosperms such as *Poa annua* and *Agrostis stolonifera*). Apart from a few pilot experiments, the ‘Aliens in Antarctica’ project, a project in the framework of the International Polar Year 2007-2008, is the first study to obtain a comprehensive insight in the extent of propagules (e.g. spores, seeds, eggs) which are unintentionally imported via freight or by persons entering the region (as member of a scientific program or as a tourist) by their clothes, shoes, or hand luggage.

The aim of the project was to sample, by means of special vacuum cleaners, clothing, shoes, and “carry-on” luggage of a randomly chosen set of passengers of ships and planes, entering the region from outside the Antarctic. Besides, as many visitors to the Antarctic as possible were invited to complete a questionnaire, revealing their itineraries prior to the journey to the Antarctic region, indicating possible sources of alien propagules.

Preliminary results of this project will be presented and a few tentative conclusions will be drawn.

What do interception data really tell us about actual insect invasions in Europe?

Alain Roques (1), Marc Kenis (2), Wolfgang Rabitsch (3) & Marie-Anne Auger-Rozenberg (1)
(1) INRA UR0633, Station de Zoologie Forestière, 45075 Orléans, France ;
alain.roques@orleans.inra.fr.
(2) CABI Europe-Switzerland, 2800 Delémont, Switzerland
(3) Biodiversity and Nature Conservation, 1090 Wien, Austria

The 2005-2008 European project DAISIE (*Delivering Alien Invasive Species Inventory in Europe*) aimed at delivering the first continental inventory of the alien species of animals and plants already established in Europe. It revealed that alien insect species are establishing in Europe at a mean rate of 15.9 species per year since 2000 whereas this rate was ca. twice less 25 years ago (9.5 species/ year). A major part of these species have phytophagous habits and arrived accidentally with human activities, less than 10 % being parasites/ predators deliberately introduced for biological control. It was therefore interesting to compare these data with the interceptions reported by the national quarantine services of the European countries, which essentially concern phytophagous pests registrated on quarantine lists (A1 and A2).

A total of 238 alien species were identified at species level in the notifications of non-compliance reported by EPPO for the European countries for the period 1995-2005. Among the 1315 alien insect species today considered as established in Europe, a total of 183 species of which 114 phytophagous have been recorded to have established during the same period. Only 7 of these species (i.e., 6.1%) have been intercepted before their establishment.

Although the insects arriving from Asia were dominant in both interceptions and establishments, representing 38.2 and 35% of the species respectively, the taxonomic composition of the two groups significantly differed. Coleoptera (30.6% without any dominant family), followed by Hemiptera (25.7% with a dominance of aphids and scales) largely dominate the alien species established during 1995-2005. In contrast, the quarantine interceptions during the same period mostly consisted of Diptera (30.7% of which 66.7% of agromyzids) and Hemiptera (30.0% among which 82.7% of aleyrodids), far above Coleoptera (17.8%). Overall, the taxa including small-sized sucking insects appeared to be significantly more represented in the entomofauna which established than in the interceptions. A comparison of the biological traits shown by the species which were intercepted but never established with these of the species which were never intercepted but established is under progress and will be presented at the meeting.

Invasions of amphipods in aquatic ecosystems of North-Western Russia: pathways and consequences

Nadezhda A. Berezina
Zoological Institute, Russian Academy of Sciences, University emb. 1, Saint-Petersburg, 199034, Russia

At present, the number of non-indigenous invertebrates in different parts of the world has increased, resulting in structural and functional changes of aquatic ecosystems. Since the middle of the XX century, six species of Ponto-Caspian amphipods (*Chaetogammarus ischnus, C. warpachowskyi*, *Chelicorophium curvispinum*, *Dikerogammarus haemobaphes*, *Obesogammarus crassus*, *Pontogammarus robustoides*), one Baikalian amphipod *Gmelinoides fasciatus* and one amphipod of Atlantic origin *Gammarus tigrinus* have expanded in North-Western Russia and adjacent regions. The aim of this study is to analyse the possible pathways for recent amphipod invaders to European Russia, focusing mainly on the north-western region. Fundamental causes of invasion, or why a species was transported; possible invasion routes including known invasion corridors; vectors of invasions, or how a species is transported and consequences of their successful establishment (impact on recipient communities) are discussed. A wide variety of human mediated vectors facilitates the dispersion of amphipods in different directions. It is a rapid process owing to the natural ability of amphipods to migrate great distances and successfully establish under new conditions. The life cycle traits facilitating successful establishment of amphipods in new habitats were illustrated on example of most successful invaders. As a rule, invasive amphipod belong to opportunistic species or r-strategists, which be able to increase their density over a short period. They are characterized by high fecundity, fast growth and maturation of juveniles; wide food spectrum, high genetic variability and tolerance to different factors, including pollutants. The destruction of natural habitats will increase ecosystem invasivibility and facilitate the success of invaders. The success of invading species strongly depends on life cycle traits and the strength of their interactions with other species. In the recipient ecosystem, the established alien species can become the dominant species which can strongly influence on the ecosystem. The Predation Impact Index (IP) was applied for assessment of amphipod impact on invertebrate community (Berezina 2007). The IP is the ratio between the consumption rate (C_p) of the amphipod population and total production of their prey (P_{pr}) for a given period ($IP = C_p/P_{pr}$). The predation impact of amphipods on the community was ranked as high ($IP > 1$), middle ($0.5 < IP < 1$) and low ($0 < IP < 0.5$). Results allowed to conclude that spread of invasive amphipods, such as *G. fasciatus* and *P. robustoides* in aquatic ecosystems of Russia has had a high ecological impact, leading to changes in pre-existing biota, losses of species diversity and destabilization of recipient ecosystems through food web alterations. Other non-indigenous species belong to invaders with medium and low ecological impacts on the ecosystems, as they do not have the potential to dominate the ecosystems and often coexist with populations of native species without affecting the dynamic structure and stability of the ecosystem.

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Propagule pressure, not climate mainly limits *Fallopia x bohemica*'s current distribution

Thomas Spiegelberger (1), Fabien Anthelme (2) & Frédéric Gourgues (3)
(1) Cemagref Grenoble, F-38402 Saint-Martin-d'Hères, France;thomas.spiegelberger@cemagref.fr
(2) IRD Montpellier, UMR DIA-PC, B.P. 64501, F -34394 Montpellier
(3) Gentiana, Botanical Society of the Dauphine, F-38000 Grenoble

Exotic species threat biodiversity worldwide making invasions by non-native organisms to one of the major risk. Climate change including higher temperature is likely to increase the invasive range of many species. This is confirmed by numerous environmental envelope models (EEM) which predict a further expansion of many alien species. However, propagule pressure is only rarely taken into account in such models. Moreover, current distribution of invasive species on which most EEM are based, may not reflect the species physiological limits, but only current propagule dispersion.

In this study, experimental planting of rhizomes of Bohemian knotweed (*Fallopia x bohemica*) along an altitudinal gradient in two contrasting habitats in the French Alps is used to examine the roles of climate, propagules pressure, disturbance and neighbouring plants on the performance of a plant highly invasive in the lowland. While it seems obvious that climate is a major constraint for the establishment of non-native species, the key question is whether the current distribution of *Fallopia* is limited the above mentioned factors or the results of several interactions between these factors.

At three different altitudinal levels (montane [M, 1100 m], sub-alpine [S, 1950 m], and alpine [A, 2550 m]), a grassland (G) and a scree (S) frequently disturbed by hang slides were selected resulting in a total of six experimental plots where *Fallopia* rhizomes were randomly assigned and planted in the middle of 15 hard plastic trays per plot. Soil from the study plots was previously filled in the trays which were then put back in the dug hole and buried to the brim. Rhizomes were planted on 02/07/2007 and presence, height, diameter and productivity (height x diameter) of each plant were assessed regularly until 27/10/2007 when all above-ground parts of *Fallopia* died back. Total native plant cover and cover of native dead plants were visually estimated for each tray. At each experimental plot, meteorological data was measured (air temperature in °C and relative humidity).

Minimal and mean temperature changed with altitude and minimal temperature shifted across habitats. Mean germination rate of *Fallopia* for both habitats decreased with altitude and was similar for both habitats in the M-zone (41 %). However, plants germinated significantly better in the SS compared to the SG (53 vs. 23 %), while the opposite was observed in the A-zone (S: 0 %, G: 24 %). We therefore conclude that current distribution of *Fallopia* is mainly reflecting propagule pressure and not physiological limits. Similar results were obtained for productivity, which also decreased with elevation, and was two times higher in the SS compared to the SG. We suppose that germination and productivity is facilitated in the climatically more severe A-zone (mean temperature: 6°C) by the presence of existing dwarf vegetation (cover of living plants: AG: 61 %, AS: 2 %), while in the SG (mean temperature 11°C) competition for resources may limit germination and productivity of *Fallopia* (cover of living plants: SG: 84 %, SS: 19 %).

Alien plant invasion patterns in the Swiss Alps: is bioclimatic origin a driving factor?

Sylvia Haider (1), Hansjörg Dietz (2) & Ludwig Trepl (1)
(1) Technische Universität München, Chair of Landscape Ecology, Department of Ecology and Ecosystem Management, Am Hochanger 6, 85350 Freising, Germany
(2) ETH Zurich, Plant Ecology Group, Institute of Integrative Biology, Universitätsstrasse 16, 8092 Zürich, Switzerland

Mountains represent ecoregions that have not been in the focus of invasion ecology although they comprise many natural or semi-natural ecosystems potentially modified by alien plant invasions. Studying invasion processes in mountains is very interesting because mountains can serve as model systems to analyze the factors limiting the spread of invasive plant species along environmental gradients. Particularly, mountains are suited for studying climatic limitations of plant invasions.

The success of establishment and further spread of alien plant species depends strongly on climatic aspects – both climatic conditions of the invaded area and bioclimatic origin of invasive species. Our hypotheses are: (1) Species with different bioclimatic origin show different (altitudinal) distribution patterns, (2) species with climate matching colonize more bioclimatic zones along altitudinal gradients than species without climate matching, (3) species with climate matching are spreading faster and with higher abundance from disturbed areas into more natural habitats, and (4) distribution patterns in the invaded and the native area of a species are equal, if the climatic conditions are the same. Furthermore, we hypothesize that global warming will not promote all invasive species, but the influence will depend on the bioclimatic origin of the species and the climatic conditions in the new area.

To test these hypotheses we compared the occurrence of plant species of Mediterranean origin and plant species of temperate origin along mountain pass roads in the Swiss Alps. During two vegetation periods we examined the ‘vertical’ distribution as well as the ‘horizontal’ spread of plants from disturbed roadsides into more natural habitats. The results will show the importance of climate matching for the invasion success and its influence on the distribution patterns of invasive species and therefore will be a relevant factor for assessing the risk of future invasions

Alien plants in southern South America IV. Chile and Argentina, levels on the mutual risk of invasion

Nicol Fuentes (1), (2), (3), Eduardo Ugarte (1) & Stefan Klotz (2)
(1) Universidad de Concepción, Departamento de Botánica, Chile
(2) UFZ, Helmholtz Centre for Environmental Research - Department Community Ecology, Halle, Germany
(3) Martin-Luther-University, Institute of Geobotany and Botanical Garden, Halle, Germany

Chile and Argentina share a long border line, a common history of colonization and alien floras. Thus, alien floras in each country are potentially a source of new species for its counterpart or a source of diaspora which increment propagule pressure through repeated attempts of introduction. We evaluated the magnitude at which alien flora from one country could represent a threat and a risk for the other. We recognize three potential approaches on the evaluation of mutual invasion risk between Chile and Argentina: *i*) national alien floras as sources of new aliens for the other country; *ii*) alien species dispersing through road borders that are not present on the flora of the other country; *iii*) alien species on road borders already present on the other country increasing propagule pressure. We used a modified version of Weed Risk Assessment (WRA) method (Pheluong et al. 1999) to assess the potential risk of invasion of the alien flora in both countries. We evaluated alien species present only in Chile for their WRA index values as potential invaders of Argentina and vice versa. 84% of 288 alien species present only in Chile were rejected as non-suitable for introduction in Argentina (50% potential invaders of agricultural fields, 41% potential environmental invaders and 9% facultative). In turn, 81% of 283 alien species present only in Argentina and absent in Chile were rejected as non-suitable for introduction into Chile. (47% are potential invaders of agricultural fields, 40 % potential environmental invaders and 13% facultative). 29 aliens species present only in Chile, were also found on Chilean roads (52% agricultural invaders, 9% environmental invaders and 5% are facultative). While none of the aliens species present only in Argentina was found on road borders. Among those species representing the higher levels in risk are species from *Rubus*, *Rosa* and *Carduus.* Consequently, Chile represents a far bigger threat in terms of alien plants introduction to Argentina than vice versa.

Spatio-temporal models for the spread of invasive alien plants: Bayesian inference and risk assessment

Glenn Marion (1), Stephen Catterall (1), Adam Butler, Stijn Bierman (1) & Alex Cook (2)
(1) Biomathematics & Statistics Scotland, James Clerk Maxwell Building, The King's Buildings, Edinburgh EH9 3JZ ,UK
(2) Department of Plant Sciences, University of Cambridge, CB2 3EA UK

A Bayesian approach for parameter estimation in stochastic spatio-temporal models for the spread of invasive species across landscapes is developed, tested and applied. Statistical techniques, such as logistic, and autologistic, regression, typically outstrip stochastic spatio-temporal models in their ability to handle covariate information. However, this work addresses such problems by making use of a range of covariates describing the bio-geographical features of the landscape. Relative to regression techniques, stochastic spatio-temporal models are more transparent in their representation of biological processes. They also explicitly model temporal change, and therefore do not require the assumption that the species' distribution (or other spatial pattern) has already reached equilibrium as is often the case with standard statistical approaches. In order to illustrate the use of such techniques we apply them to the analysis of data detailing the spread of invasive plants across Britain in the 20th Century using geo-referenced covariate information describing local temperature, elevation and habitat type. The use of Markov chain Monte Carlo sampling within a Bayesian framework facilitates statistical tests of differences in the suitability of different habitat classes for each species, and enables probabilistic predictions of habitat suitability and future spread to be mapped, in a manner that accounts for parametric uncertainty and system variability (Figure 1). Initial methods [1] made use of the raw records, comprising observed presences in Ordinance Survey 10X10km grid squares (hectads) along with a time window during which the observation was made, available from the National Biodiversity Network (www.nbn.org.uk/) which collates species data in Britain and Ireland. However, the extensions to this work reported here have developed improved methods of estimation which make use of a more widely available data-type, namely on the species distributions at designated time points (i.e. species atlas data), and which fully account for the uncertainty in (unknown) colonisation times between the atlas time points. The impact of detection errors and the number, and time between, species atlases, on the reliability of inference is assessed using simulated data. Finally these methods are applied to real data and their utility in improving understanding, assessing risks, and guiding large-scale management of invasive alien plants is discussed.

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[**1**] Cook, A., Marion, G., Butler, A. & Gibson, G. (2007). Bayesian inference for the spatio-temporal invasion of alien species. *Bulletin of Mathematical Biology* **69**(6), 2005-2025.

Spatial structure and invasion dynamics of UK alien plant species

Bethan Purse1, Mark Botham (2), Mark Hill (2), Ingolf Kühn (3), Chris Preston (2) & David Roy (2)
(1) NERC Centre for Ecology and Hydrology Edinburgh, Bush Estate, Penicuik, Midlothian, UK, EH26 8LY, email: beth@ceh.ac.uk
(2) NERC Centre for Ecology and Hydrology Monskwood, Abbots Ripton, Huntingdon, Cambridgeshire, PE28 2LS
(3) Department of Community Ecology, Helmholtz Centre for Environmental Research - UFZ Theodor-Lieser-Str. 4 / 06120 Halle / Germany

Alien invasions are increasingly recognised as important drivers of biodiversity change, with knock-on consequences for ecosystem function and economies [1]. A key challenge of invasion biology is to predict and explain, against a back drop of habitat modification and climate change, (i) which kinds of species will invade and (ii) where the impacts of invasions will be felt most keenly, preferably in advance of ecosystem impacts [2]. Using UK atlas datasets, we applied different analytical tools to understand recent ranges changes in over 1000 UK alien plant species (those that have invaded wild habitats some time since 1500) between two distributional snapshots - from 1950 to 1969 and from 1987 to 1999. In this paper, we first test out whether snapshots of range structure can be related to future or past distribution changes of a species since this would permit rapid assessments of potential threats posed by different species without detailed ecological knowledge. Such relationships might arise due to the spatial signature that past extinction and colonisation events leave on a species' range. For native UK butterflies and plants, Wilson and others found that expanding species had larger more aggregated distributions for their distribution size whilst declining species had smaller sparser distributions [3]. However, characteristic signatures will differ between native and invasive species. Whilst extinctions and colonisations may occur sporadically through out the ranges of natives, as invasives move into a new land mass, their distributions extend rapidly by long distance jumps followed by filling in with local dispersal [4]. For suites of plant species with different dispersal modes, lifespans and histories of introduction, we have quantified the link between current range structure and processes of distribution change at different time points during their invasion. As well as trying to define rule sets with which to estimate the likelihood and extent of range changes in alien plant species, we are investigating the role that climate, land use changes and changes plant population connectivity have played in determining where different invasive will spread to and have impact. This has been achieved by statistically matching patterns of extinction and colonisation in different suites of aliens (sharing particular ecological characteristics) with concurrent changes in climate, human population density and plant population connectivity.

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Do urban areas act as foci for the spread of alien plant species?: An assessment of temporal trends in the UK

Marc S. Botham (1), Peter Rothery (1), Phillip E. Hulme (2), Mark O. Hill (1), Christopher D. Preston (1) & David B. Roy (1)
(1) NERC Centre for Ecology and Hydrology, Monks Wood, Abbots Ripton, Huntingdon, Cambridgeshire PE28 2LS, UK
(2) National Centre for Advanced Bio-Protection Technologies, PO Box 84, Lincoln University, Canterbury, New Zealand

Given that urban landscapes often act as a point of entry for many non-native species and urban development continues to increase as the human population rapidly expands, an understanding of the interaction between urbanisation and non-native plant species is important both in the control of potentially invasive species and the conservation of native biodiversity.

We investigated the spatial and temporal relationship between urban land cover and the distribution of non-native species in Britain using two floristic datasets collected at two different time periods: 1987-88 and 2003-04.

The number of natives and aliens recorded in 2003-04 showed an increase from 1987-88. Neophytes (alien species introduced after 1500) were very strongly associated with urban land cover in both time periods and do not appear to be spreading out of urban habitats into the wider countryside. Archaeophytes (alien species introduced before 1500), however, showed a strong association with urban habitats in the earlier 1988 dataset but no longer showed this association in the 2004 dataset.

Analysis at the individual species level showed that a large percentage of alien plant species, particularly archaeophytes, were not strongly associated with urban land cover or were negatively associated with such habitats. We therefore suggest that this reduction in the urban association of archaeophytes is likely to have resulted from the recovery of archaeophytes associated with non-urban (especially arable) habitats, following their decline mid twentieth-century, rather than from the movement of aliens into the wider countryside from urban habitats.

Uncertainties in risk of establishment and spread of a population introduced into a spatially heterogeneous environment

Ullrika Sahlin, Göran Bengtsson & Henrik Smith
Department of Ecology, Lund University, Sölvegatan 37, SE-223 62 Lund, Sweden

Biological invasions caused by the introduction of alien populations are one domain of Ecology that give rise to uncertain risks. With uncertainty we here mean the variation in risk that appears from disregarding information of the process under study. Analyses of uncertainties in risk provide the confidence to make good selections of determinates of risk, and to find the balance between generalising and going into detail. We analysed the uncertainty in risks related to the establishment and spread of an introduced population. We performed a simulation experiment of a dynamic population model (an integrodifference equation) in an environment defined by a stochastic patch model. The influence on risk and uncertainty for different spatial structures of the environment and species traits, such as the sizes and distances of suitable patches and intrinsic growth rate and density dependence in settlement rate, respectively, were compared. We found that the way factors dominate the influence on uncertainty and risk varies between events in the invasion chain and with the values on other factors.

Assessing, classifying and scoring the environmental impact of invasive insects in pest risk analyses

Marc Kenis (1), Marie-Anne Auger-Rozenberg (2), Sylvie Augustin (2), Sven Bacher (3), Matthew J.W. Cock (1), Carlos Lopez-Vaamonde (2), Christelle Péré (1), (4), Therese Pluess (3), Alain Roques (2), Josef Settele (5) & Laura Timms (6)
(1) CABI Europe-Switzerland, 2800 Delémont, Switzerland; m.kenis@cabi.org
(2) INRA, Station de Zoologie Forestière, 45166 Olivet, France.
(3) University of Fribourg, Department of Biology, 1700 Fribourg, Switzerland
(4) University of Neuchâtel, 2009 Neuchâtel, Switzerland
(5) UFZ – Helmholtz Centre for Environmental Research, Department of Community Ecology, 06120 Halle, Germany
(6) University of Toronto, Faculty of Forestry, Toronto, Canada M5S 3B3

In pest risk analyses, one of the most difficult questions to answer is whether the pest under analysis is having an environmental impact in its region of occurrence and, even more difficult, whether it is likely to have an environmental impact in the region for which the pest risk analysis is carried out. There is presently no satisfying method to classify, rank and score the environmental impact caused by an invasive pests. Environmental impacts of pests, particularly insects, have been explored for a limited number of species. In this study, we first carried out an extensive literature survey, which identified over 400 primary research publications that investigated the environmental impacts of 72 invasive alien insects and/or the mechanisms underlying these impacts. Evidence for environmnetal effects in the field was found for 58 insect species. Most publications investigated impacts on native biodiversity at population or community level. Genetic impacts and, to a lesser extent, impacts on ecosystem services and processes were rarely explored. We classified the effects caused by different invasive insects according to: their ecosystem roles, i.e. herbivores, predators, parasites, parasitoids and pollinators; the level of biological organisation at which they occur; the direct and indirect mechanisms underlying these effects. The best documented effects occur in invasive ants, Eurasian forest herbivores invasive in North America, and honeybees. Impacts may occur through simple trophic interactions such as herbivory, predation or parasitism. Alien species may also affect native species and communities through more complex mechanisms such as competition for resources, disease transmission, apparent competition, or pollination disruption, among others. Finally, some invasive insects, particularly forest herbivores and ants, are known to affect ecosystem processes through cascading effects.

These data are presently used to categorise environmental impacts of alien insects and define indicators and impact indexes that can be used to assess present and potential environmental impacts in pest risk analyses. The first results will be presented at the conference.

Assessing the ecological impact of alien leafminers through apparent competition. The example of *Cameraria ohridella*

Christelle Péré (1,2), Sylvie Augustin (3), Rumen Tomov (4), Ted Turlings (2) & Marc Kenis (1)
(1) CABI Europe-Switzerland, rue des Grillons 1, 2800 Delémont, Switzerland
(2) University of Neuchâtel, rue Emile Argand 11, CP 158, 2009 Neuchâtel, Switzerland
(3) INRA, 2163 av. de la Pomme de Pin, BP 20619, Ardon, 45166 Olivet Cedex, France
(4) University of Forestry, Bul. Kliment Ohridski 10, 1756 Sofia, Bulgaria

Apparent competition is defined as a negative effect between species at the same trophic level that do, or do not share resources, mediated through the action of shared natural enemies. Although it is thought to be one of the mechanisms through which invasive species affect populations of native species, very few examples are known, particularly in insects.

The horse-chestnut leaf miner, *Cameraria ohridella*, is an invasive moth that was first discovered in Macedonia in 1984, and has since invaded most of Europe. It is now attacked by several native parasitoids and predators. Despite the low parasitism rates observed in *C. ohridella*, populations are so high that an unusual amount of polyphagous parasitoids are produced in the vicinity of infested horse-chestnut trees, two or three times per year. In spring, the bulk of the parasitoids emerge at least six weeks before the first suitable *C. ohridella* larvae or pupae are available. These parasitoids can massively attack the first indigenous leaf miners developing in spring. Predators may also increase in numbers near *C. ohridella* outbreaks. In the present study, carried out in Switzerland, France and Bulgaria, we tested the hypothesis that the presence of *C. ohridella* has an influence on the populations of native leaf miners through shared natural enemies.

The species richness of native leaf miners' communities was lower in the presence of *C. ohridella*, particularly in spring. Population densities of some leaf miners sharing their parasitoid complex with *C. ohridella*, such as the beech and oak leaf mining weevils, *Orchestes fagi* and *O. quercus*, and several leaf mining moths, were significantly lower close to horse-chestnut trees infested by *C. ohridella*. Studies are currently carried out to investigate whether these decreases are due to parasitoids or predators associated with *C. ohridella*.

The actual ecological and economic impact of alien mammals in Europe

Elfi Kühnel (1), Sven Bacher (2) & Wolfgang Nentwig (1)
(1) University of Bern, Community Ecology, Baltzerstrasse 6, 3012 Bern, Switzerland
(2) University of Fribourg, Ecology & Evolution Unit, Ch. du Musée 10, 1700 Fribourg, Switzerland

Aim of the study was to evaluate the presently known ecological and economic impact of 35 alien mammals of non-European origin in Europe. Since most impact knowledge is descriptive, we quantified it by a transformation into numerical values. We distinguished five categories of ecological impact (impact on fauna: competition, predation, hybridisation and transmission of diseases and the impact on flora) and five categories of economic impact (on agricultural plant production, agricultural animal production, forestry, human health and on the abiotic environment) each scaled from zero to five according to the strength of the impact. The actual distribution of a species was included into our calculations by a factor of 0.5 to 5, thus the highest total impact value per species is 5 (impact categories) x 5 (strength of impact) x 5 (area) x 2 (ecological and economic impact) = 250. The highest ecological and economic impact is caused by Norway rat (*Rattus norwegicus*) with an impact value of 160, muskrat (*Ondatra zibethicus*) impact with a value of 140 and coypu (*Myocastor coypus*) with a value of 125. Our approach allows ranking and comparing species with different types of impact and of different taxonomic and dietarian groups. Ecological impact was highest from carnivores, while economic impact is highest in rodents. Total impact is highest in carnivores.

Status and impact of invasive weeds on native communities in Shiwalik hills, Himachal Pradesh, India

Daizy R. Batish, R.K. Kohli & Kuldip S. Dogra
Department of Botany, Panjab University, Chandigarh – 160014, India

Biological invasion is a world wide phenomenon and occurs when a species enters new ecosystem away from its place of origin, establishes there and cause harmful effects on native species. Increasing trade and better transport have greatly enhanced the process of biological invasion. The rapid spread of invasive plant species has homogenized the world flora and is detrimental to global biodiversity. In fact, invasive species pose second most devastating effect on biodiversity after habitat destruction or fragmentation. It is therefore essential to check the fast spread of these species in un-invaded ecosystems and this can be achieved only if their status and impact on the structure and dynamics of native communities is known. It is thus worthwhile to undertake such studies in the unexplored ecosystems. For the present study, Shiwalik range (located between 30°22′94″N to 33°12′40″N and 75°45′55″E to 79°04′20″E, altitude and varying between 244 to 6,750 m msl) of hilly Indian state Himachal Pradesh were selected where a survey was made to determine the current status and impact of invasive flora on the native plants. Basically, Shiwaliks represent the lower most geologically younger range of northwestern Himalayas and are foothills or Himalayan tracts. Based on the survey, nearly 200 alien species were identified which belonged to different taxonomic families predominantly Asteraceae, Fabaceae and Poaceae. Most of these species originated from South America and entered India either accidentally or deliberately for various purposes. Presence of open sites owing to overgrazing, eroded undulated land and indiscriminate felling of trees, besides anthropogenic reasons, are mainly responsible for enhanced invasion process in this part of the country. Among the alien species, plants like *Parthenium hysterophorus* L., *Ageratum conyzoides* L., *Eupatorium odoratum* L., *Lantana camara* L. and *Tagetes minuta* L. are found to be highly invasive and thus very harmful. These plants interfere with the native vegetation and change their structure and dynamics as revealed by reduction in species number, biomass and changes in various ecological indices of diversity, dominance and evenness. Of the invasive weeds, *L. camara* was found to most destructive in nature as it has encroached most of the hilly region, especially the forests. Owing to its shrubby perennial nature and allelopathic phenomenon the weed forms its huge monocultures where it is virtually impossible to invade and undertake forestry operations. *P. Hysterophorus,* another harmful weed, adversely affect the native herbaceous flora and cause health problems to the people as well as livestock. It is very difficult to control this weed and requires a great effort at community level. Another weed, *A. conyzoides* has created havoc with agricultural crops as it invades arable land and cause economic loss to the farmers. In addition to these three weeds, *E. odoratum* and *T. minuta* are still in the process of invasion and these form patchy distribution at the favourable sites. If not controlled timely, these weeds are likely to acquire harmful proportions to the detriment of the ecosystem. During the presentation, it is proposed to discuss all aspects pertaining to impact of invasive species on the local flora.

Quantitative synthesis of impacts of invaders in Europe

Montserrat Vilà (1) & DAISIE partners (2)
(1) Estación Biológica de Doñana (EBD-CSIC), Avda/María Luisa s/n, Pabellón del Perú, 41013 Sevilla, Spain, e-mail: montse.vila@ebd.csic.es
(2) Delivering Alien Invasive Species Inventories for Europe" EU research project (www.aliens-europe.org)

Alien species cause important ecological and economic impacts worldwide. However, compared to other current research issues in invasion biology, the impact of aliens on ecosystem services remains poorly understood**.** Ecological and economic impacts of alien organisms are usually distinguished separated, but they are highly correlated. A better approach is to examine the continuum of impacts across the breadth of ecological services. We present the first pan-European assessment of the impacts on ecosystem services and human well-being of alien plants, vertebrates and invertebrates in terrestrial, inland aquatic and marine environments based on data provided by the DAISIE project (www.europe-aliens.org). Overall, 1094 (10% of all alien species) and 1347 (13%) species recorded naturalising in Europe are known to have ecological or economic impacts, respectively. Invaders from all taxonomic groups affect ecosystem services and interfere with human well-being. Terrestrial vertebrates account for the broadest range of impacts on ecosystem services and are for the widest distribution of species with known impact. Probably, for smaller taxonomic groups or less invaded regions the information on impacts may be proportionally greater. Current economic valuations of invaders in Europe focus primarily on provisioning services. Conservation, agriculture, forestry and fishery are the main economic sectors identified where alien species cause outstanding direct costs in Europe.

Can species traits predict hazard levels of plant pests?

Therese Pluess
University of Fribourg, Department of Biology, Ecology & Evolution Unit, Ch. du Musée 10, 1700 Fribourg, Switzerland

In the present study we look for the first time at species traits for predicting hazard levels. We focus on organisms of phytosanitary concern and collect data of established plant pests belonging to different taxonomic groups (weeds, insects and micro-organisms). The level of impact these pests have on environment, economy and society is quantified. Species traits are then used as explanatory variables to predict impact levels. We thus expect to identify common species traits responsible for high impact levels. Our findings will be validated and are to be integrated in PRA schemes currently being developed in the EU-wide project PRATIQUE. The final aim is to provide Pest Risk Analysts with scientifically funded tools and thus enabling them to collect the relevant data on species in the course of a Pest Risk Analysis.

Contrasting alien and native plant species-area relationships: the scale-dependence of risk assessment

Philip Hulme
National Center for Advanced Bio-Protection Technologies, PO Box 84, Lincoln University, Canterbury, New Zealand

Increasingly the proportion of alien plant species in floras is used to indicate the threat of invasions on native species and/or the homogenisation of biodiversity. However, this indicator is only valuable if it is independent of the spatial extent and grain of observation. This study tested the equivalence of native and alien species area relationships (SAR) in order to assess the support for scale-invariance in the proportion of alien species in floras. Nested SARs were generated by assessing the richness of native and alien plant species drawn from the New Atlas of the British and Irish Flora for six areas comprising 100, 400, 900, 1600, 2500 and 3600 km2 with each larger area containing all smaller areas. Five replicate sets of nested areas encompassing northern, southern, eastern, western and central regions were chosen. For each set of nested areas, the log-transformed species richness was regressed on log-transformed area to fit a power function to the SAR. Native and alien plant SAR reveals consistent differences in slope, highlighting that the proportion of alien species is a function of spatial grain. Aliens are rarer than natives and have higher spatial turnover leading to faster accumulation of species as area increases. However, equivalent samples drawn from a larger spatial extent reveal similar alien and native SARs. The significant differential scale-dependence in native and alien species richness observed in this study reflects dissimilar influences of regional drivers such as habitat but potentially also propagule pressure and introduction history that leads to the relative rarity and high spatial turnover of alien species. Maps of invasion hotspots that identify areas where the proportion of the alien flora is particularly high should therefore be treated with considerable caution since patterns across most grains used for species monitoring will be scale-dependent.

A risk assessment of alien mammals in Europe

Manuel Kobeltl (1), Sven Bacher (2) & Wolfgang Nentwig (1)
(1) University of Bern, Community Ecology, Baltzerstrasse 6, 3012 Bern, Switzerland
(2) University of Fribourg, Ecology & Evolution Unit, Ch. du Musée 10, 1700 Fribourg, Switzerland

The introduction of alien mammals to Europe is a permanently ongoing and still increasing process. In this study, the potential risk which results from the occurrence of 39 unintentionally introduced mammals alien to Europe is analysed. The analysis bases on the Australian risk assessment which for our needs had been slightly modified to European needs. It contains three major components: (1) an analysis of risk to public safety, (2) an analysis of establishment risk basing primarily on climate matching and ecological features, (3) an analysis of pest risk basing primarily on area, habitats and ecological features.

(1) We found no risk to public safety caused by introduced mammals. (2) The establishment risk was extreme for 21 introduced mammals, 4 mammals showed a high risk, 7 a moderate risk and 7 showed a low establishment risk. (3) The pest risk analysis showed 23 species with an extreme pest risk, 10 with a high and 6 with a moderate pest risk. None of the analyzed species showed a low pest risk.

Based on our risk assessment predictions for the further development of introduced species are possible. Also predictions of the potential risk for the future of recent or potential invaders can be made. Since the risk assessment is climate-based also potential effects within climate change scenarios can be predicted.

Generally speaking, it is very important to have a robust prediction tool to classify the potential risk of mammal species. We predict for the near future a permanent increase in the number of alien mammal species in Europe and an increase of their ecological and economic impact.

An overview of the risk analysis and management framework for the use of alien species in European aquaculture

Gordon H Copp (1) & Ian G. Cowx (2)
(1) Cefas, Salmon & Freshwater Fisheries Team, Pakefield Road, Lowestoft, NR33 0HT, UK
(2) Hull International Fisheries Institute, University of Hull, Cottingham Road, Hull, HU6 7RX, UK

In response to new legislation in the European Union, a risk analysis and management framework was developed by the EC-funded project '*IMPASSE*' [1] to foster environmentally sound practices for the introduction of non-native species and the translocation of locally-absent species in aquaculture, including quarantine procedures, and risk assessment protocols. Based on protocols espoused by the European Plant Protection Organisation (EPPO)[2] and founded on the 'ICES' [3] and 'EIFAC' [4] codes of practice, the *IMPASSE* risk framework is structured using an internet-based modular system, jointly developed by EPPO and the UK non-native species risk analysis panel [5]. The *IMPASSE* scheme consists of four principal modules (pathway/delivery, facility, organism, ecosystem), with complementary modules for assessing invasive-ness potential, for quantifying economic impacts and for summarising risk and the uncertainties associated with the assessment process. The invasiveness modules [6] are adapted versions of the weed risk assessment scoring sheet of Pheloung, Williams & Halloy [7]. The sub-modules for quantifying socio-economic impacts and for summarising risks and uncertainties are adapted forms of the GB risk scheme [8]. The quarantine and risk management modules were developed from generic protocols for quarantining and containment, including use of the UK Environment Agency decision-tree protocol for fish stock enhancement.

The scheme will facilitate recommendations and guidelines to allow for phylum-specific peculiarities (Algae, finfish, molluscs, Crustacea), developmental stage, GMOs, and the risks associated with potential pathogen and parasite carriage, genetic impacts on wild stocks and possible ecosystem and environmental change. Due attention will be paid to the scale of risk for each organism type to distinguish routine movements (low risk) from those requiring a comprehensive risk analysis (high risk). The qualitative and quantitative aspects of the scheme will be summarized and discussed, and the conceptual framework of the management decision process will be presented.

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Risk assessment of invasive species introductions via inland waterways

Vadim Panov (1), Boris Alexandrov (2), Kestutis Arbaciauskas (3), Rosa Binimelis (4), Michal Grabowski (5), Frances Lucy (6), Rob Leuven (7), Stefan Nehring (8), Momir Paunović (9), Vitaliy Semenchenko (10) & Mikhail Son (2)
(1) St. Petersburg State University, St. Petersburg, Russia, (2) Institute of Biology of the Southern Seas, Odessa Branch, Odessa, Ukraine,; (3) Vilnius University, Institute of Ecology, Vilnius, Lithuania, (4) Autonomous University of Barcelona, Spain, (5) University of Łódź, Łódź, Poland, (6) Environmental Services Ireland, Institute of Technology, Sligo, Ireland, (7) Radboud University Nijmegen, The Netherlands R.Leuven@science.ru.nl (8) AeT umweltplanung, Koblenz, Germany, (9) Institute for Biological Research "Sinisa Stankovic", Belgrade, Serbia, (10) Institute of Zoology, National Academy of Sciences, Minsk, Belarus

European network of inland waterways facilitates the transfer of invasive alien species (IAS) across European inland waters and coastal ecosystems, which requires appropriate risk assessment-based management options to address risks posed by human-mediated introductions of these species. During the development of methods to assess the risks of IAS introductions via European inland waterways we considered the **DPSIR** framework ('**D**riving forces', '**P**ressure', '**S**tate', '**I**mpact', '**R**esponse') to structure developed environmental indicators in the socio-economic context. In addition, considering the current gap in addressing IAS in the river basin management in Europe, our goal was to develop and test relevant risk assessment protocols and water quality indicators on IAS for possible consideration in the Common Implementation Strategy of the EC Water Framework Directive and as part of a holistic risk-based management of European river basins. Owing to the high degree of scientific uncertainty when dealing with such a global and complex ecological issue as large-scale intercontinental and intra-continental introductions of IAS, the qualitative model of risk assessment was selected for risk assessment of IAS introductions via European inland waterways. The present variant of this model of risk assessment of IAS introductions, tested for selected assessment units within the main inland water invasion corridors, includes seven main components:

1. Identification of main invasion gateways, routes and corridors in Europe;
2. Selection of ecosystems as assessment and management units (AUs) within invasions corridors/invasion network;
3. Identification and analysis of pathways of IAS introductions within the ecosystem AU – '**D**riving forces' according to the DPSIR framework;
4. Assessment of inoculation rates within the ecosystem AU (propagule pressure) – DPSIR '**P**ressures';
5. Assessment of biological contamination level of the ecosystem AU - DPSIR '**S**tate';
6. Assessment of invasiveness of the established in the ecosystem AU alien species (potential biopollution risk) - DPSIR '**I**mpacts';
7. Development of an online Risk Assessment Toolkit with early warning service for reporting of environmental indicators and recommendations for risk management to stakeholders – DPSIR '**R**esponses'.

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A bio-economic model for the uncertain invader: linking spread and impacts for pest risk analysis

Luis R Carrasco Torrecilla (1), Alan MacLeod (2), Jon D Knight (1), Richard Baker (2) & John D Mumford (1)
(1) Imperial College London at Silwood Park, Buckhurst Road, Ascot, Berkshire, SL5 7PY
(2) Central Science Laboratory, Sand Hutton, York, YO41 1LZ

Ex ante quantification of the potential economic impacts posed by invasive pests is a very complicated and yet an essential task. In order to facilitate quantification, policy makers are in need of integrated models that link pest spread and impacts and that allow for scaling up impacts from field to farm to industry. Conversely, pest invasions are a highly complex and uncertain process with multiple interactions between the pest, the environment and independently acting actors, i.e. farmers, government and society. To account for that complexity, theoretical reflections and empirical methods alone might be limited. Multi-agent simulation (MAS) that integrates individual decision making with the biophysical environment of the invasion, in a common spatial framework, might be a necessary complement [1].

We present an integrated model for the ex-ante assessment and management of the risk of pest invasions (Figure 1). The model is composed of: (i) a spatially explicit stochastic simulation sub-model that integrates dispersal and population dynamics of the pest, (ii) a MAS of the farmers' pest control behavior and (iii) an aggregation module that scales up the farmers' reactions into a sector model for welfare distribution analysis. The model is linked to a Geographical Information System (GIS) to allow for model inspection and risk communication.

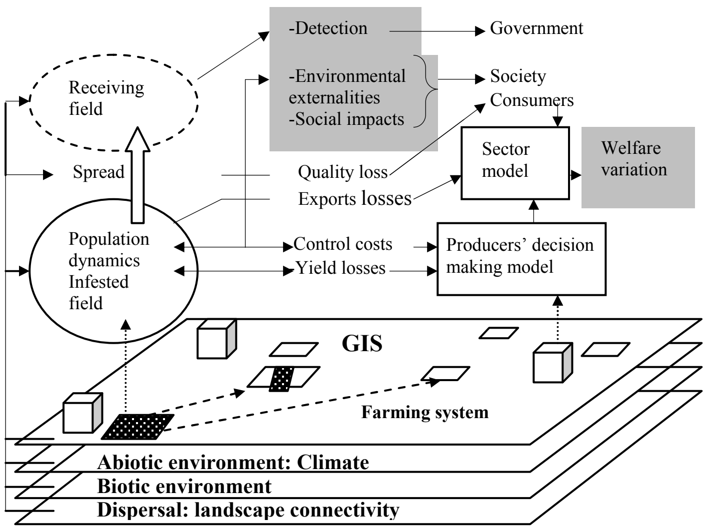

Figure 1: Schematic representation of the model linking spatial spread with farmers' decisions and scaling them up to a sector model. Shaded boxes represent final impacts. F: Farmer.

We illustrate the use of the model with a case study of the current invasion by *Diabrotica virgifera virgifera* in England. Simulation results show that by considering the feedback mechanisms between individual farmer decisions and the invasion, we are able to provide plant health policy makers with a simulator that by linking spread and impacts helps to scale up, under different invasion scenarios, the potential economic impacts of the uncertain invader.

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Habitat-based mapping of risk from plant invasions in Europe

Petr Pyšek (1), (2), Milan Chytrý (3), Vojtěch Jarošík (2), (1) & Montserrat Vila (4)
(1) Institute of Botany, Academy of Sciences of the Czech Republic, Průhonice, Czech Republic
(2) Institute of Botany and Zoology, Masaryk University Brno, Czech Republic
(3) Department of Ecology, Faculty of Sciences, Charles University Prague, Czech Republic
(4) Biological Station Doñana (EBD-CSIC), Avda. María Luisa s/n, Pabellón del Perú, E-41013 Sevilla, Spain

Although the importance of habitat and land-use in plant invasions is widely recognized, data to test their role are largely missing. A large database of vegetation plots, comprising over 20,000 of vegetation records in fine-scale plots in the Czech Republic, was used to (i) assess the invasion in habitats classified according to the standard European EUNIS system, (ii) evaluate the relative importance of habitat identity, propagule pressure and climate, and (iii) separate the actual level of habitat invasion (i.e., the number of alien species that are found in a habitat) from its invasibility. To distinguish the level of invasion from habitat invasibility requires to factor out the effect of propagule pressure and climate, and compare the habitats under the assumption of these two variables being equal. At a regional scale, propagule pressure can be quantified using proxies related to human activities, such as the proportion of surrounding urban/industrial or agricultural land and human density in the area of sampled plot. These results demonstrate that habitat identity is the most important predictor of the level of invasions by alien plants, expressed as the alien-to-all-species proportion in plots, while propagule pressure and climate explain much less variation in data. At the scale of few to hundreds of square meters, habitat types explain much more variation in the level of invasion than climate or alien propagule pressure. Moreover, it has been shown that patterns of habitat invasions are consistent among European regions (Czech Republic, UK and Catalonia) with contrasting climates, biogeographic affinities, history and socio-economic background. These findings make a solid background for mapping the risk of plant invasion, based on the projection of the habitat-specific levels of invasion onto land cover maps. The resulting map predicted higher invasion risk in lowland areas of the temperate zone of central and western Europe and lower risk in the boreal zone, mountain regions across the continent, and extremely oceanic areas of northwestern Europe. Low invasion risk was also predicted in the Mediterranean region except its coastline and areas with irrigated agricultural land.

Cameraria ohridella spatial dynamics and invasion genetics

Sylvie Augustin (1), Marc Kenis (2), Romain Valade (1), Marius Gilbert (3), Alain Roques (1) & Carlos Lopez Vaamonde (1)
(1) Institut National de la Recherche Agronomique, UR633 Zoologie Forestière, CS 40001 Ardon 45075 Orléans, France
(2) CABI Europe-Switzerland, Delémont, Switzerland
(3) Université Libre de Bruxelles, Biological control and spatial ecology, CP 160/12, 1050 Brussels, Belgium

Although many organisms are capable of spreading by their own within a new area, biological invasions are associated with human activity, and long- distance dispersal events of anthropogenic origin are susceptible to increase the rate of spread. In the invaded area, the new arriving population is subjected to a founder effect followed by a rapid expansion. It results in a loss of genetic diversity with regard to the original population.

The horse-chestnut leaf miner, *Cameraria ohridella* Deschka & Dimič (Lepidoptera: Gracillariidae) is illustrative of this process. This moth was first discovered in Macedonia near the Ohrid lake in the early 1980s and rapidly spread to most European countries. Its main host tree is the horse-chestnut *Aesculus hippocastanum* which originates from the Balkans, but maples, *Acer pseudoplatanus* and *A. platanoides* can occasionally be used as host. In all regions where the moth is present, it causes aesthetic damage to horse chestnuts which are widely planted as ornamentals in most of Europe, especially within urban areas. Using large scale data, several invasion models were compared and showed that the best model was a stratified dispersal incorporating the effect of human population density. In parallel, the genetic variability of *C. ohridella* populations was investigated in order to trace the geographical origin of the moth in Europe. Mitochondrial sequences were analyzed to test the hypothesis that *C. ohridella* comes from the Balkans. The moth populations sampled in the parks invaded across Europe showed a severe decrease in genetic diversity compared to the moth populations sampled in the natural stands of horse-chestnut in the Balkan mountains. These results suggest that the populations of *C. ohridella* nowadays present in Western, Central and Northern Europe may indeed originate from the Balkans.

Poster presentations

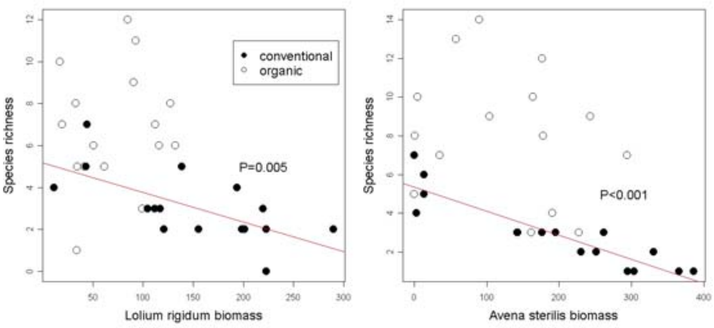
Could cropping system (organic vs. conventional) modify the effect of invasion on agroecosystem weed diversity?

Laura Armengot, Laura José María, Albert Romero-Puente, Lourdes Chamorro, José M. Blanco-Moreno & F. Xavier Sans
Universitat de Barcelona, Departament de Biologia Vegetal/ Botànica; Diagonal Av., 645. 08028, Barcelona, Spain. http://www.ub.edu/agroecologia

Dryland cereal weed communities are dominated by few species, among which some grasses are considered serious agricultural pests (e.g. *Lolium rigidum*, *Avena sterilis*) [1]. Although the effect of native weed infestation on crop yield has been widely studied [2] less research has been conducted on their effect on resident weed communities despite it could be important in driving abundance and diversity decline of resident weed populations. In addition, the effects of an invasion could be different between cropping systems (organic vs. conventional) since they create different conditions (resident weed diversity, rate of nutrients release, nutrient availability, etc.) that could affect invasion success [3, 4].

The aim of this study is to analyse the effect of *A. sterilis* and *L. rigidum* invasion on resident weed diversity in relation to the cropping system. We selected two close winter wheat fields, one conventional and one organic, in Catalonia (NE Spain) and an invasion through seeding at three densities of *A. sterilis* (165, 830 and 1670 seeds·m^{-2}) and *L. rigidum* (500, 1500 and 3000 seeds·m^{-2}) was simulated. Every treatment (seeding density) was assigned to four 2 × 2 m plots randomly placed in each field. Four blank plots (not seeded) were included. After the seed addition, each field was sown with 200 kg·ha^{-1} of wheat. Before crop harvest, total aboveground biomass of four 25 cm × 25 cm squares was clipped from each plot, sorted into species, dried and weighted. Our results show that *A. sterilis* and *L. rigidum* invasion affected negatively species richness only in the conventional field (Fig 1).

Figure 1: Weed species richness with respect to invader biomass (g·m^{-2}) in conventional and organic fields. Only linear regressions for conventional field are included. Significant P-values are next to each line.



According to this, the invasion effects on resident weed diversity do not only depend on the identity of the invader, i.e. *A. sterilis* or *L. rigidum*, but also on the complex crop-invader-resident weeds interactions which differ in organic and conventional cropping systems.

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Alien plants in southern South America I . Historical perspective and global diversity

Nicol Fuentes (1,2,3), Eduardo Ugarte (1), Ingolf Kühn (2) & Stefan Klotz (2)
(1) Universidad de Concepción, Departamento de Botánica, Chile
(2) UFZ, Helmholtz Centre for Environmental Research - Department Community Ecology, Halle, Germany
(3) Martin-Luther-University, Institute of Geobotany and Botanical Garden, Halle, Germany

We used alien and native species in Chile and Argentina to identify alien invasion periods. We assumed that the pattern of accumulation of species can be used for tracing back distribution in time of alien species introductions in both countries. We adapted Proportion Curves methodology. Increments in the proportion of alien vs. native species can be interpreted as expansions in population size of alien, either locally or by invasion of new areas. In Chile, the first expansion phase of alien (1910 to 1940) coincides with a first period of strong growth of Chilean agriculture. A second one (1980 to 2000) occurs when: i) wheat productivity increase and ii) forestry exports increase. Also in Argentina there are two phases of alien expansion. The first one (1915 to 1935) coincides with increments of wheat production and a second one (1960 to 1975) is related with increments in livestock production. A comparison between the alien floras of Chile and Argentina reveals: i) higher alien species diversity in Chile than in Argentina at family, genera and species level. ii) Europeans plant had a strong influence contributing with more than fifty percent on the alien flora in both territories. iii) Main families were *Poaceae, Asteraceae* and *Fabaceae* and iv) traits "herbs – annual" are highly represented in both floras. On both, historical and floristic perspective, alien floras in Chile and Argentina are similar. Thus, we hypostatize that constant increase in species movement caused by globalization, should increase overall biotic homogenization in southern South America.

Alien plants in Southern South America II . Road-border flora both sides of The Andes; are aliens following natural gradients?

Francisco Lira (1), Eduardo Ugarte (1), & Stefan Klotz (2)
(1) Laboratorio Ecología Vegetal, Departamento de Botánica, Facultad Cs. Naturales y Oceanográficas Universidad de Concepción, Chile. Email:flira@udec.cl
(2) UFZ Helmholtz Centre for Environmental Research - Department Community Ecology, Germany

As a basis for assessing risk of invasion, we explore the role of roads on alien plants expansion at both sides of the Andean Cordillera between Chile and Argentina. We set up the following questions:

- Do latitudinal gradients influence floristic composition on road-borders both sides of the Andes?
- What is the effect of altitude on road-border floristic composition?

We sampled floristic composition on road-borders randomly every 5-6 km . We selected five roads connecting both sides of the Andes covering the Mediterranean climate - Temperate rainy transition in Chile.
Results indicate that:

a) Both sides of the Andes differ in alien/native species proportion. In Chile aliens are constantly more than two thirds of the flora. In Argentina from one-fourth to two-thirds, with a higher fraction of natives, but diminishing from north to south.
b) Most of aliens in road borders are European and, as in alien floras elsewhere, *Poaceae*, *Asteraceae* and *Fabaceae* were the best represented families
c) In both sides natives increase with elevation while aliens diminish.
d) Multivariate analysis (DECORANA) separate on first axis Chilean from Argentinian locations while a second axis correlates with latitude. First axis on an ordination of Chilean locations only corresponds well with latitude and the second one with altitude.

Patterns of alien distribution should be explained under two perspectives:

a) Aliens are responding primarily to a biogeographical-latitudinal and altitudinal gradients

b) Alien expansion is responding to four centuries of human settlement on the Mediterranean zone against only one century on the south temperate – rainy zone.

Trait differentiation and the success of exotic species: towards a trait based predictive framework of species invasions

Alejandro Ordonez (1), Han Olff (1) & Ian Wright (2)
(1) University of Groningen
(2) Macquarie University

Human-induced changes in natural ecosystems, such alteration to global biogeochemical cycles, land-use change and the mobility of biota, are currently occurring at an unprecedented rate, threatening ecosystems functioning and services. From these, biological invasions are one of the most important components. As organisms need to be equipped for life in a given environment, the question of "how well does an exotic species need to be equipped", or what

syndrome of traits must it possess to survive and flourish, becomes a fundamental question to understand invasiveness. To test this idea plant traits form native and exotic species (SLA, Hmax and seed mass) expanding over 592 plant communities' surveys combinations (7234 native species and exotic 1463 species) where compared. At the continental and community level, individual traits were significantly similar between exotics and their native counterpart.

These similarities were observed within life forms (trees, shrubs, herbs/forbs and grasses) and habits (annual/biannual – perennial, and evergreen deciduous). Trait space comparisons based on convex hull polygons, showed differences between plant types group means. On average exotics had 12% higher Specific leaf area, 8% higher canopy height and 87% smaller seeds, but more importantly, it's reveled that native exotic trait composition is significantly different from the native trait composition and the mean community mean trait value. Based on the level of individual trait similarity and occupied region in a multidimensional trait space, successful exotics do not have a fundamentally distinct trait composition but rather occupy different region of the trait space.

Preference-performance of *Cameraria ohridella* (Lep.: Gracillariidae) on *Acer pseudoplatanus* (Sapindaceae)

Christelle Péré [1, 2], Ted Turlings [2] and Marc Kenis [1]
[1]CABI Europe-Switzerland, rue des Grillons 1, 2800 Delémont, Switzerland
[2]University of Neuchâtel, rue Emile Argand 11, CP 158, 2009 Neuchâtel, Switzerland

The horse-chestnut leaf miner, *Cameraria ohridella*, is a moth of unknown origin that was first observed in Macedonia in 1984 and has now invaded most of Europe. It is mainly a pest of the white flowering horse-chestnut, *Aesculus hippocastanum*, a tree native to the Balkans and introduced into Central Europe as an ornamental urban tree, in the sixteenth century.

Field observations and screening test showed that the moth can also oviposit and develop on other *Aesculus* and *Acer* species. High infestations of *C. ohridella* can be found on *Acer pseudoplatanus* situated close to infested horse-chestnut. However, there are important variations in the oviposition rates and development success of *C. ohridella* on *A. pseudoplatanus*. These variations could be due to differences in the ability of *A. pseudoplatanus* varieties to attract the moth and develop resistance reactions, or to *C. ohridella* populations that have become adapted to maple. The main objective of this study is to understand the mechanisms of the association *Acer-Cameraria* and determine whether *C. ohridella* may shift to a native maple, *A. pseudoplatanus.*

The first experiments, carried out in the field, in Switzerland, showed that females oviposit on different deciduous species. However, *A. hippocastanum* remains the preferred host-plant. Among the other potential host-plants, *A. pseudoplatanus* is clearly preferred for oviposition, but more than 80% of the larvae die in the first two instars. On-going experiments show that the oviposition preference and larval performance of *C. ohridella* on *A. pseudoplatanus* vary significantly between sites and individual maple trees.

Alien plants in southern South America III. Is spontaneous flora in middle- size Chilean cities following a latitudinal gradient?

Eduardo Ugarte (1), Francisco Lira (1) & Stefan Klotz (2)
(1) Laboratorio Ecología Vegetal, Departamento de Botánica, Facultad Cs. Naturales y Oceanográficas Universidad de Concepción, Chile. Email:edugar@udec.cl
(2) UFZ Helmholtz Centre for Environmental Research - Department Community Ecology, Germany

Cities and roads are extremely human - modified habitats for plant species. Both, as a system, need to be taken into account, then, when evaluating conservation of natives or invasions by alien plant species. As part of a study aimed to evaluate risks of plant invasions in Chile, we sampled six cities, covering the transition between mediterranean-climate zone and temperate rainy zone.To our knowledge, this is the first study performed in Chilean cities. We aimed to answer following questions:

- Is flora in cities responding to climate transitions?
- Are patterns of distribution along the gradient similar for native and alien plants?

We used Braun-Blanquet`s releves to sample urban habitats for spontaneous flora avoiding city borders or transition to rural habitats.

Our results indicate that around 90 % of plant species in midle-size cities are alien, with 77 to 88% of European origin. This ciphers are higher than in Concepción (77 % aliens), a big urban complex included for the sake of comparison.

Between 96 and 98 % of species are herbaceous increasing in number towards the southern part of the gradient. Annuals and perennials, however, reach similar proportions along the gradient. Best represented families were *Asteraceae* and *Poaceae* both including 40 to 50% of species.

Proportion of aliens is higher than other cities in the world (e.g 54 European cities between 19 to 60%; Mexico City 20%).

Multivariate analysis (DECORANA) shows climatic gradient as the main factor ordering cities indicating that both natives and aliens seem to be responding first to climate, cities keep groups of species diferentiating drier from more humid biogeographic extremes.

A global risk assessment for the success of bird introductions

Miquel Vall-llosera & Daniel Sol
Centre for Ecological Research and Forestry Applications (CREAF), Autonomous University of Barcelona (UAB); E-08193 Bellaterra, Catalonia, Spain

Concern over the impact of invaders has motivated the development of risk assessment methodologies to identify potentially invasive species and use them to prevent future ecological and economic problems. However, developing a risk assessment tool is difficult because it requires to accurately predict the outcome of species introductions.

We develop a global risk assessment for birds integrating two approaches. First, we model the outcome of historical introductions (N > 800) with generalized lineal mixed models (GLMM) to identify the species-level traits that are associated with establishment success. Second, we use this information to build a risk assessment based on hierarchical tree models that helps identify those introductions with the highest risk of success.

Establishment success was related to characteristics that pre-adapt non-native species to the novel locations, such as a broad ecological niche and a large brain, as well as to factors related to introduction effort (number of individuals released) and the location of introduction (island vs. mainland), confirming and generalizing previous studies. The tree model predicted the risk of establishment success with high accuracy, highlighting that this risk can be reasonably assessed with information on general habitat use, brain size and the size of the founder population. When compared with an alternative risk assessment methodology, our model achieved similar accuracy with less information requirements.

Our analyses indicate that a quantitative risk assessment based on traits related to establishment success is difficult but feasible, confirming the utility of the approach for guiding preventive polices aimed to mitigate the impact of invaders.

Biological invasion and dispersal mechanisms

3.2. Assembly processes in meta-communities

Luis Santamaria, Wolf Mooij, Daan Gerla, Michael Kleyer

Oral presentations

The evolutionary ecology of community assembly in metacommunities

Mathew A. Leibold
University of Texas at Autin; Section of Integrative Biology, 1 University Station, Austin, Texas, 78712, U.S.A.

Community assembly is the iterated process whereby species enter a local community via dispersal. They may then establish populations and alter the structure of the resident community and alter future colonizations, and extinctions. Historically this process has mostly considered an arbitrary species pool with fixed species attributes but recent thinking in metacommunity ecology and evolution in structured populations suggest that this view may be too simplistic. Additionally, such thinking suggests that dispersal rate and patch connectivity in metacommunities may strongly influence the assembly process. I will provide several examples of theory and experiments that suggest how this may be so.

First, I will consider how dispersal among patches in the absence of evolution affects community assembly. Dispersal plays two important roles by a) providing colonists that fuel the assembly process and by allowing maladaptive types to establish in local communities via source sink relations. I will use patch occupancy models to examine community and metacommunity assembly in two models to show that the consequences of dispersal depend on the rate of background local population extinctions.

Second, I will consider the role of dispersal among patches in the presence of adaptive microevolution. Using a simple model, I will show that several outcomes are possible that I characterize as ‘species sorting’, ‘local monopolization’ and ‘global monopolization’ and that which outcome is obtained depends on the relative rates of dispersal, mutation, and local temporal environmental change.

Finally, I will review published evidence and results of ongoing studies supporting these general models.

Colonization dynamics in cyclical parthenogens: priority effects versus local adaptation

Joost Vanoverbeke & Luc De Meester
KULeuven, Laboratory of Aquatic Ecology and Evolutionary Biology; Ch. Deberiotstraat 32, 3000 Leuven, Belgium

Processes like dispersal and adaptation not only influence community assembly but also population assembly within species. The resemblance between community and population assembly mechanisms may be especially high in cyclical parthenogens, where clonal lineages during the parthenogenetic phase can be regarded as genetically independent species. Indeed, in *Daphnia* the initial period of colonization of a new pond, before the occurrence of the first phase of sexual reproduction, may be very important in determining the long term genetic structure of the populations. In this context, the monopolization hypothesis [1] predicts that early colonizers will have an enormous advantage over secondary immigrants because of priority effects and increased relative fitness due to local adaptation. This will result in a strong resistance to gene-flow after initial colonization, even if dispersal rates are high. To investigate the relative importance of priority effects versus selective processes in shaping the early genetic composition of cyclical parthenogenetic populations, we perform simulation experiments in which we study colonization dynamics of clones in the presence and absence of selective differences between the clones. For this we use an individual based physiologically structured model [2], in which we can incorporate neutral genetic markers as well as selective differences between the clones in a number of physiological and life-history traits (ingestion rate of food, assimilation rate, size at birth, investment in growth versus reproduction, ...). For a range of migration rates and levels of productivity of the system, we analyse genetic diversity within and genetic differentiation among populations over time. Incorporation of selective differences among clones may alter the results obtained from the neutral model in two ways. On the one hand, early introduction of selectively favoured clones may strengthen priority effects by further decreasing the probability of successful establishment of later immigrants. On the other hand, establishment success of later immigrants may be facilitated if their relative fitness is high compared to the average fitness of the population.

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Intra-specific variability, competition–colonisation trade-off, and species coexistence in vegetation communities

Benoit Courbaud, Georges Kunstler,G. & Ghislain Vieilledent
Cemagref –Montain Ecosystem Research Unit
2 rue de la Papeterie, BP 76, 38402 Saint-Martin-d'Hères cedex - France

This past decade, the classical ecological theory, which consider trade-offs among species and niche differences as key to coexistence, has been challenged by the neutral theory which states that species differences are too small to be of prime importance in highly diverse communities such as tropical forests [1]. The overlap between the distributions of individual life traits among populations of different species is usually high. Looking only at mean species differences could lead to an overestimation of the role of low-dimensional trade-offs in community dynamics [2-4]. A recent simulation study with a model of two-species plant community shows that intra-specific variability can indeed modify the long-term outcome of competition between species and that its effect depends on species fecundity [5]. The question arises then on how much intra-specific variability contradicts or enhances the effect of a colonization-competition trade-off on species coexistence. In this presentation, we first evaluate inter-specific and intra-specific variability in growth and allometries for Norway spruce and European Fir, two tree species coexisting in the Alps. We then use a community patch-model based on competition between seedlings to analyse how taking into account growth intra-specific variability changes predictions of community dynamics. In a two species simulation experiment, we show that intra-specific variability can modify competition asymmetry between species. It allows a very fecund species to produce some highly competitive individuals, and win part of the sites in competition. In agreement with classical theory, seed-limitation of the best competitor appears necessary for stable coexistence at the community scale. Nevertheless in our framework, given enough overlap between growth distributions, a very fecund species can exclude a species of higher mean growth. When both species are highly fecund, a fecundity - mean growth trade-off line separates conditions leading to exclusion of one species or the other. Time before exclusion and relative importance of contingent processes simulated stochastically increase as species get closer to this trade-off condition. Intra-specific variability has a paradoxical effect on species coexistence. On one hand it allows unstable coexistence of fecund species by reducing differences between their best individuals. On the other hand it sometimes destroys clear species complementarities necessary for stable coexistence. We argue that crude ranking of species competitive and colonization abilities are not enough to predict long term community dynamics. It depends on a fine balance between species life traits, as well as on there variability among individuals and along time.

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Testing meta-community paradigms: Evolutionary isolation of tree crowns affects Heteroptera species assemblages

A. Vialatte (1), R. I. Bailey (1), C. Vasseur (1), A. Matocq (2), M. Gossner (3), D. Everhart (1), X. Vitrac (4), A. Belhadj (4), A. Ernoult (1) & A. Prinzing (1)
(1) UMR Ecosystèmes, Biodiversité, Evolution, Université de Rennes 1, 263 AVE du Général Leclerc, CS 74205, 35042 Rennes Cedex, France
(2) Museum national d'Histoire naturelle, Département Systématique & Evolution, 45 rue Buffon, F-75231 Paris Cedex 05, France
(3) Institute of Ecology, Friedrich-Schiller-University, Dornburger Str. 159, 07743 Jena Deutschland
(4) Polyphénols Biotech, ISVV, Université Victor Segalen Bordeaux 2, 146 rue Léo Saignat, 33076 Bordeaux Cedex, France
Correspondance: aude.vialatte@univ-rennes1.fr

The role of dispersal for community assembly is increasingly recognized. However, different theoretical paradigms (Island biogeography, Patch dynamics, Mass effect and Metapopulation paradigms) make very divergent predictions on how dispersal affects community richness and structure. These predictions have not been tested together in nature. The forest canopy represents a landscape composed of patches of distinct evolutionary histories, the crowns of individual trees. We studied Heteroptera richness, abundance and trait composition in taxonomically isolated and non-isolated oak tree crowns in order to compare support for predictions of the four main metacommunity paradigms. Despite the short distances of only less than 150 meters between taxonomically isolated and non-isolated trees we found major differences between their Heteroptera faunas. We show that taxonomically isolated trees support smaller numbers and fewer species of Heteroptera, an increasing proportion of phytophages and a decreasing proportion of omnivores, and proportionally more non host-specialists. Comparison with theoretical predictions indicates that the assembly of local Heteroptera communities is strongly driven by independent metapopulation processes at the level of the individual species.

Colonization-extinction dynamics of epiphytic species in a boreal forest landscape

Katja Fedrowitz (1), Mikko Kuusinen (2), Jan Bengtsson (1) & Tord Snäll (1)
(1) Swedish University of Agricultural Sciences, Department of Ecology, Ulls väg 16, P.O. 7044, SE-75007
Uppsala, Sweden
(2) Ministry of the Environment, Kasarmikatu 25, P.O. Box 35, FI-00023 GOVERNMENT, Finland

In order to judge species extinction risk in changing landscapes due to forestry or climate change it is important to get a better understanding of the spatial dynamics of species living in changing landscapes. We study the metapopulation dynamics of epiphytes that have aspen (*Populus tremula*) as host trees in the boreal old-growth study site. Colonization and extinction events are recorded during 2008 at the study site that was initially surveyed in 1995. Study species are the epiphytic lichens *Nephroma bellum*, *N. resupinatum*, *N. parile*, *N. laevigatum*, *Lobaria pulmonaria*, *Leptogium saturninum*, *Protopannaria pezizoides, Parmeliella triptophylla*, and the epiphytic moss *Neckera pennata*. We test the relative importance of connectivity and local conditions on colonizations of, and extinctions from trees. Local conditions to be tested are such as tree diameter, shade, and proportion of other epiphytic species growing on the same tree. We will also investigate the consequences of tree dynamics on future metapopulation size. The presentation will show the most important factors for colonization and extinction dynamics of the study species. We will also discuss whether these system features can be generalized for other epiphytic species and for other spatial scales.

A new allometric modelling approach for home range formation in animal communities in fragmented landscapes

Carsten Buchmann 1, Florian Jeltsch [(1)] & Ran Nathan (2)
(1) University of Potsdam, Plant Ecology and Nature Conservation, Institute of Biochemistry and Biology; Maulbeerallee 2, 14469 Potsdam, Germany
(2) Movement Ecology Laboratory, Department of Evolution, Systematics and Ecology, Alexander Silberman Institute of Life Sciences, The Hebrew University of Jerusalem, Givat Ram, 91904 Jerusalem, Israel

The spatial distribution and structure of animals' home ranges, as well as the corresponding patterns of individuals' abundance are two major factors governing terrestrial ecosystems. In addition to the importance of their contribution to a broad understanding of animal communities, these patterns also heavily control animal-driven ecosystem processes, which often acting at the community level, as e.g. resource consumption or food competition, but also more complex processes as zoochorous seed-dispersal. Therefore focussing on mechanisms determining spatial distribution and composition of a whole animal community seems to be an essential first step, also for further investigation of issues as those mentioned above. Although species-level home range models exist, there is generally a lack of mechanistic understanding about these patterns at the community level. We link a new allometric approach for determining relevant physiological properties of terrestrial animals with an individual-based algorithm for home range selection. This algorithm incorporates locomotion costs as well as resource depression and competition. Our model predicts the size and location of individual home ranges in realistic landscapes, as well as the body mass-abundance relationship in an animal community. Our model agrees with independent empirical data in predicting that home range size scales with M^{1} and that population density scales with M^{-1}, which previously has been interpreted to be valid in disturbed habitats. Model predictions are robust against variation in habitat productivity and the shape of input distributions. Our results show that the combination of allometric relationships with spatially-explicit, individual-based simulations is a powerful tool for exploring mechanisms of home range formation at the community level in realistic landscapes.

The influence of dispersal on zoo-, phyto- and bacterioplankton community response to productivity gradients

Dino Verreydt (1), Steven Declerck (1), Ellen Decaestecker(1,2), Maria Villena Alvarez(3), Katleen Van der Gucht (3), Pieter Vanormelingen (3), Wim Vyverman (3), & Luc De Meester (1)
(1) Laboratory of Aquatic Ecology and Evolutionary Biology, Catholic University of Leuven, Ch. Deberiotstraat 32, B-3000 Leuven, Belgium
(2) Interdisciplinary Research Center, K.U.Leuven Campus Kortrijk, E. Sabbelaan 53, B-8500 Kortrijk, Belgium
(3) Laboratory of Protistology & Aquatic Ecology, Ghent University, Krijgslaan 281-S8, B-9000 Ghent, Belgium

Freshwater community composition is influenced by both local and regional factors. Local community diversity is strongly influenced by the biotic and abiotic environment, but exchange of species among local communities through dispersal may also potentially be very important.

An important local structuring factor is productivity. Studies indicate that there is a variety of relationships between productivity and local species diversity. One potential reason for this is that productivity interacts with other important factors. For example, dispersal among communities may mediate community response to a productivity change. Dispersal itself can also be influenced by productivity. Highly productive systems are characterized by higher species densities, and will potentially act as more important sources of dispersing individuals than low productive systems (asymmetric dispersal).

We performed an outdoor mesocosm experiment in which we exposed 16 different plankton communities from different trophic backgrounds to two productivity levels and three levels of dispersal intensity. High productivity had a negative influence on most zooplanktonspecies in our study. Dispersal had a positive impact on some species. There was a productivity x dispersal interaction, with the strongest community response to the productivity gradient at the highest level of dispersal intensity. This was mainly due to the large cladoceran species *Daphnia magna*, that became very common and abundant in highly productive tanks subject to high dispersal and which resulted in enhanced grazing rates of zooplankton on phytoplankton. Both phyto- and bacterioplankton showed the highest community response to the productivity gradient at low levels of dispersal, higher levels of dispersal intensity, however, opposed the community response.

The functional traits that drive anemochorous species response to habitat isolation

Andrea Schleicher, Michael Kleyer & Robert Biedermann
University of Oldenburg, Landscape Ecology Group; Carl von Ossietzky Str. 9-11, 26111 Oldenburg, Germany

There is increasing evidence that several functional traits impact on plant species susceptibility to habitat isolation. For anemochorous species seed mass, terminal velocity and seed number seem to play an important role, yet it remains unclear if they act additive or if they reflect different strategies. Moreover, the relative importance of dispersal traits may interfere with prevalence as prevalence can be thought of as both a cause and an effect of spatial distribution patterns. Due to their low dispersal ability rare species may thus be less prevalent than common species and simultaneously face a higher level of habitat isolation.

We applied a spatially explicit approach in an urban brownfield area to reveal functional traits that drive the response of 52 anemochorous ruderal species to habitat isolation. Habitat isolation was described by calculating habitat and species specific connectivities based on the distances between occupied habitats and their areas.

The majority of species was affected by spatial habitat isolation. Species with a positive response to connectivity showed higher dispersability in terms of terminal velocity and higher seed number than non-responsive species. While seed number effects emerged irrespective of species prevalence, terminal velocity was positively correlated with prevalence.

Our results suggest that the prevalence of anemochorous species strongly relates to their dispersability but high seed number may recompensate for low dispersability irrespective of prevalence. We conclude that both dispersability and seed number determine a species general susceptibility to habitat isolation, acting as two complementary strategies to counteract spatial habitat isolation.

Niche and dispersal assembly in species-rich grasslands

Ove Eriksson & Mathias Öster
Department of Botany, Stockholm University, 106 91 Stockholm, Sweden, ove.eriksson@botan.su.se

Semi-natural grasslands in Scandinavia with a long history of management (grazing or mowing) have a very high local species density, often 40-50 species/m^2. If management ceases, or if the grasslands are fertilized, the species-density declines rapidly, probably as an effect of inter-specific competition from dominant species. However, it is still an unresolved issue which mechanisms operate during assembly and maintenance of species richness of these grasslands. Two main models may be postulated, niche assembly and dispersal assembly (*sensu* [1]). Niche assembly implies that inter-specific competition is a dominating interaction, and that species utilize available niche space, but constrained by limiting similarity. Dispersal assembly implies that the local species composition reflects the inflow of species from the regional species pool, and that communites are open for colonization. Maintenance of species and trait diversity is thus basically due to recruitment limitation [2]. Several results indicate that dispersal assembly is most important for these grassland communities. Recruitment increases with experimentally manipulated propagule pressure [3], at levels above the average natural seed rain [4]. Despite strong evidence for a seed size/seed number trade off among grassland plants, there is no support for a colonization/competition trade-off during recruitment [4, 5]. Experimental manipulation of functional groups, legumes and dominating forbs, does not alter recruitment significantly above background levels, indicating that the communities are essentially open for colonization [3]. Small-scale species richness is positively related to the local species-pool size [6], and most examined species have dispersal limited recruitment [7].

Here we report results from an ongoing experiment where the functional profile of grassland communities, based on an assumed persistence trait (SLA), was manipulated, and the communities were subjected to sowing and transplantation from a set of species varying in functional traits. Based on the niche assembly model, we expect that species with traits corresponding to those removed will have an advantage in establishing in the community, whereas no such effect is expected under the dispersal assembly model.

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No evidence of complementarity in assembly of Bibury road verge plant community

Ken Thompson & Owen Petchey
Department of Animal and Plant Sciences, University of Sheffield, Sheffield S10 2TN, UK
Correspondence: ken.thompson@sheffield.ac.uk

It has long been recognised that powerful forces, particularly soil and climate, tend to make the plant species that share a habitat more similar than one would expect by chance. One recognition of this is the existence of the Raunkiaer life-form classification. At the same time, particularly at small spatial scales, competition is expected to promote diversity among co-existing species. Indeed a belief in complementarity of resource use is fundamental to the notion that more-diverse plant communities can achieve higher productivity than monocultures.

We looked for complementarity in the flora of the Bibury road verge, where the composition of eight fixed 1 x 0.5 m quadrats has been determined in most years since 1958. Functional diversity (FD) of actual quadrats was compared with FD of quadrats randomly assembled from the complete pool of species at the site. Traits used to generate FD were either 16 mature plant traits, seven regenerative (seed) traits, or the complete set of 23 traits. In all three cases, actual quadrats had lower FD than random quadrats. In other words, co-existing species are more similar than one would expect by chance. Since the road verge is relatively uniform, and therefore the forces tending to homogenise local patches can only be weak, this suggests that processes tending to generate niche differentiation are also weak.

We further examine how robust this result is to variation in species included, different null models, different clustering algorithms, different measures of functional diversity, and different sets of traits.

On the repeatability of community composition

Lasse Ruokolainen, Esa Ranta, Mike S. Fowler & Veijo Kaitala
University of Helsinki, Department of Ecology and Evolutionary Biology; Viikinkaari 1, PO. Box 65, 00014 Helsinki University, Finland

A timely issue in ecology is whether the assembly of species communities can be predicted from species demographic traits, or are they a result of neutral drift. We analyzed a model of community assembly, where the starting point was a resource gradient, partitioned by a collection of interacting species after Lotka-Volterra competition. We began with an empty habitat patch (containing the resource gradient) that was let to be colonized by a random immigration process (a realistic assumption especially for passively dispersed organisms; e,g., [1, 2]). All species were able to colonize the focal patch from a global species pool, which was considered to contain an equal proportion of all the species. Established populations we further affected by demographic stochasticity allowing for local extinctions. We simulated this stochastic community assembly for 1000 time steps. After iterating this procedure for several times, we scored the similarity of resulting communities using commonly applied metrics.

The results — in terms of species presence and their abundance — demonstrated that such stochastic processes in population renewal as dispersal and demographic stochasticity may lead to a low repeatability in community structure in niche-based models. A comparison between the niche-based competition model and another model with neutral competition indicated that community assembly may resemble neutral drift in natural conditions if stochastic population processes are able to override deterministic forces affecting community assembly. Our results introduce a potential problem for distinguishing between neutral and niche-mediated processes in natural communities. In addition, the results show that a common process — that is deterministic in origin — is capable of creating communities that have essentially nothing in common (although the environment is the same for all community replicates). While this is interesting in its own right, it also implies that interpretations of community similarities (e.g., in form of gradient analysis) should perhaps be more cautious.

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Allee effects cause priority effects

Daan J. Gerla & Wolf M. Mooij
Netherlands Institute of Ecology (NIOO), Rijksstraatweg 6, 3631 AC Nieuwersluis, The Netherlands
Corresponding author: d.gerla@nioo.knaw.nl

When does the order in which species arrive to colonize a new habitat matter for the composition of the species community that develops on the long run? If species that arrive early have a better chance of establishing a population than species that arrive later, a priority effect occurs. Priority effects may occur because population growth is rapid relative to immigration rates so that later colonizers face an already crowded habitat and have a high chance of going extinct. This failure to invade an established (resident) population can occur even if differences between species are neutral, i.e. if they are effectively equal. However, given enough time and invasion attempts, eventually an immigrant will drift into the population. Thus, an additional mechanism is required to maintain population homogeneity on longer timescales.

In the contribution I propose here, I will propose the Allee effect as a general mechanism that can cause and maintain on the long run a priority effect through positive feedback of density on fitness. The Allee effect is defined as a positive correlation between per capita growth rate and population density in small populations. With a weak Allee effect there is only this correlation, with a strong Allee effect there is threshold population density below which the population goes extinct. Allee effects can have many causes, such as difficulty with finding a mate in sexually reproducing organisms and better protection against predation in groups. But also more simple organisms can have an Allee effect, e.g. phytoplankton populations may suffer from photoinhibition at low population densities, whereas high densities provide protection against high light intensities through shading.

I will present the simplest model that includes both Allee effects and intraspecific competition. The model is a multispecies extension of Vito Volterra's model that has a strong Allee effect [1]. I will discuss the circumstances under which a priority effect occurs (Figure 1). Also, I will discuss how my model approximates more realistic -but less transparent- models of population growth.

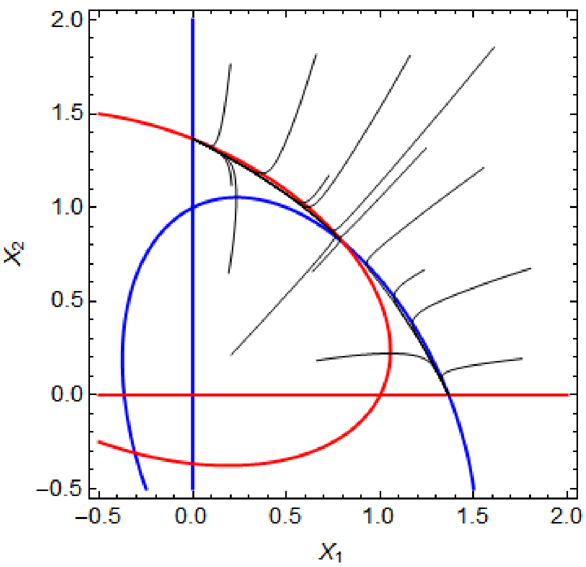

Figure 1: Phase plane for two competing species, each of which has a weak Allee effect. X_1 and X_2: densities of species 1 and 2. The blue and red curves are zero growth isoclines of species 1 and 2, respectively. Without the Allee effect, the species would coexist, however, here the Allee effect causes the outcome of competition to depend on the initial densities of the species, as shown by the trajectories (black).

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Biodiversity and function of shallow Mediterranean wetlands: the role of connectivity, dispersion and priority effects

Bertha I. Cid (1), Asier R. Larrinaga (1), Jordi Figuerola (2) & Luis Santamaría (1)
(1) IMEDEA, UIB-CSIC, Miquel Marques 21, C.P. 07190, Esporles, Spain.(2) EBD-CSIC Avda. Mª Luisa s/n, Pab. del Perú, Seville, Spain

In fragmented and naturally isolated habitats, such as wetlands, connectivity is a main driver of local diversity. However, arrival order and subsequent species sorting can determine community composition, often leading to communities and populations that are not optimally adapted to local conditions. This phenomenon is particularly pronounced in aquatic organisms, which rely on dormant propagules to persist within, and migrate among water bodies.

In Mediterranean temporary wetlands, the yearly re-establishment of aquatic communities after summer drought depends primarily on propagule-bank availability and yearly fluctuations in precipitation regimes. Propagule-bank dynamics is however dynamic, depending on inter-annual fluctuations in precipitation regimes. We used a set of restored wetlands at Doñana National Park (SW Spain) to study the relative contributions of propagule-bank build-up and priority effects on aquatic macrophytes.

We sampled 28 restored wetlands during the three years after their re-construction, to evaluate the order and timing of their colonization by aquatic macrophytes (angiosperms, charophytes and liveworths). Propagule-bank was also characterized at biennial intervals. In addition, we performed a series of mesocosms experiments in evaluate whether priority effects affect community assembly in eight restored wetlands, chosen to differ largely in their resident community structure.

Propagule bank analysis showed that the species with smallest propagules (*Riella* and *Chara*) colonized the wetlands immediately after their construction, even before flooding took place, suggesting active dispersal by wind. After the first flooding cycle, other species with larger propaglues (such as *Ruppia maritima*, *Ranunculus peltatus* and *Zannichellia palustris)* progressively colonized the wetlands, probably through hydrochory and endozoochory by waterfowl. Community composition was influenced by the order of arrival, owing to the existence of both priority effects (resistance to the establishment of immigrants in more diverse community communities) and a facilitation effect (reduced siltation in wetlands colonized by waterplants, which facilitate the stablishment of new species). Community composition in restored wetlands is therefore modulated by a complex interplay of dispersal order, priority effects and facilitation interactions, which generates a dynamic mosaic of community composition among neighbouring wetlands. We therefore propose that maintaining the connectivity and diversity of wetland characteristics (chiefly the flooding regimes) holds the key to ensure the large-scale resilience of their ecosystems.

Wind effects on hydrochorous dispersal and seed bank assembly in Dutch fen systems

Judith Sarneel, Roderick Groen , Anneke Buijze, Merel Soons & Jos Verhoeven
Utrecht University ,Institute of Environmental biology, Landscape ecology, Sorbonnelaan 16,3508 TB Utrecht, The Netherlands, j.m.sarneel@uu.nl

Introduction: Human impacts have decreased the connectivity between nature areas drastically during the last few centuries, with dramatic impact on vegetation composition [1]. In wetlands, dispersal by water (hydrochory) is of major importance for the dispersal of plant propagules, and thereby for the assembly of (new) plant communities. However, research mainly focused on streams or tidal communities. But what is the importance of hydrochory in systems where water discharges are low and flooding events are rare? What are the mechanisms? Dutch fens and fen lakes are such systems, and have a high species richness. lakes in these areas were created by peat excavation activities during the last century. They are often rectilinear in shape, ca. 100-800m long and 30m wide.We studied the dispersal of fen plants in the shallow fen lakes, and focused on the processes.

The research: Firstly, we investigated the direct effect of wind speed on dispersal speed and distance of diaspores. This was done by following polypropylene granules, (ø4mm, n=40). We found that with increasing wind speed, dispersal speed increased, but dispersal distances decreased.

During 2007, at 3 month intervals, Astroturf® mats [2] were placed at NO (upwind) and SW (downwind) sides of 4-8 fen lakes, which were NO-SW oriented. The seeds and vegetative diaspores trapped in these mats were determined and counted. The highest number of diaspores was found in November, with more diaspores trapped at the NO than SW banks of the lakes.

In March 2007, soil samples were taken from 14 NO-SW oriented fen lakes for a seed bank investigation. Samples were taken at 0 (SW), 30, 60, 75, 90 (all W) and 100% (NO) of the fen lake length. In contrast to the number of seeds trapped in the Astroturf mats, seed bank size along the length of the lakes did not increase. Isolated turf pond contained on average more seeds per liter soil.

Conclusions: Hydrochory in fen lakes with no or low discharge was directly influenced by wind speed, and diaspore deposition patterns were to be consistent with dominating wind directions. Even at low wind speeds, hydrochory was a rather fast process. Increasing wind speed increases dispersal speed, but decreases dispersal distance, probably by an increase of the probability of diaspores being trapped by the vegetation. While diaspores trapped in mats reflected the effect of wind transport, this was not found in the assembly of seed banks. Thus, other assembly processes than hydrochorous dispersal, like wind dispersal, are likely to contribute to seed bank composition.

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Trophic asspects concerning the non-indigenous Pseudorasbora parva species spreading succes in the Carpathian Basin (Romania)

Angela Curtean-Bănăduc & Doru Bănăduc
"Lucian Blaga" University of Sibiu, Department of Ecology and Environment Protection, Dr. I. Rațiu St., no. 5-7, Sibiu, Sibiu County, Romania, RO-550012

Pseudorasbora parva (Schlegel, 1842) is one of the accidentally introduced fish species in the Romanian Carpathians hydrographical net (only a half of a Century ago) and its spreading speed is one of the highest in the Carpathian Basin fish fauna. This study results highlight some trophic asspects (the broader ecologic niches; the highest degree of trophic niches overlaping; the macroinvertebrate groups with the highest relative abundance in the trophic supply; the macroinvertebrate groups present in the trophic supply used as food by the fish species) regarding this fish species competitive ecology in the native fish species communities context.

This study was carried out along 2002 - 2006 period and is based on 3124 fish individuals and macroinvertebrates quantitative samples, in 12 sampling sites localized in 11 rivers of the Carpathian Basin.

The verified hypothesis here is that the Pseudorasbora parva "new species" (neobiota) threat the native fish species, change and alter (structural and functional) the native fish communities, through its competitive ecology.

Pseudorasbora parva species it is now a common presence in the Carpathian Basin rivers and has a good tolerance to the anthropogenic impact.

The species with a relative abundance over 8% present a large ecologic valence, this is one of the possible explanation for these species regional succes. The Pseudorasbora parva species relative abundance in all the sampling sites, comparatively with the rest of the present fish species, place this neobiota species on the same place together with the actual succesfull Squalius cephalus species, close after Barbus petenyi and Gobio gobio species.

Analising the ecologic niche dimmensions of all the species in all the sampling sectors it was revealed that the broader ecological niches belong to Pseudorasbora parva, Barbus petenyi, Squalius cephalus, Gobio gobio and Romanogobio kesleri.

The comparison among the sampled fish species regarding the trophic niches overlaping degree show the fact that Pseudorasbora parva, Gobio gobio and Barbus petenyi are by far the species which are characterised by interspecific diet shift. From the fish trophic resources utilisation perspective there are two top succesful species regarding their trophic competitive atributes: Pseudorasbora parva a neobiota species with a rapid spreading speed in the last 50 years and Barbus peteny a species characterised by an important extension of the habitat in the last decades in the Romanian Carpathian hydrographical net. The following succesfull species from the trophic resources utilsation perspective are Gobio gobio and Squalius cephalus already well known for their adaptability at different environmental conditions, even there where the human impact is present. The fact that these two last species were on a second position show the specific favourable spreading situation of Pseudorasbora parva and Barbus petenyi, in this moment in the Carpathian Basin.

Factors affecting the assembly of above- and belowground communities of Marram vegetations

Martijn L. Vandegehuchte (1), Eduardo de la Peña (1), Jean-Pierre Maelfait(1,2)[2] *and Dries Bonte (1)*
(1) Ghent University, Department Biology, Terrestrial Ecology Unit, K.L.Ledegankstraat 35, B-9000 Ghent. Martijn.Vandegehuchte@UGent.be
(2) Research Institute for Nature and Forest (INBO), Kliniekstraat 25, B-1070 Brussels.

Marram grass (*Ammophila arenaria*) only thrives on dynamic white dunes with continuous sand deposition. Recently it has been put forward that the windblown sand provides a temporary "enemy-free space" where the plant can escape from a complex of pathogens that accumulate in the soil, with an important role for plant parasitic nematodes. A large body of literature deals with the plant-soil interactions of this system. Marram vegetations however also provide a habitat for a wide variety of aboveground invertebrate species (herbivores as well as higher trophic guilds). Communities of aboveground living invertebrates may consequently be structured according to cascades of biotic interactions and under influence of landscape effects. In order to assess the importance of plant genetic structure, below- and aboveground biotic interactions and landscape composition on the assembly of invertebrate communities associated with Marram grass, we combine field surveys with laboratory and field experiments. Correlations between nematode infection, plant vitality and aboveground invertebrate community structure are investigated in a large field study. In a field experiment plants from a same genetic population are placed in a different landscape context and half of them are subjected to nematode infection to test the combined effects of landscape context and belowground infection rate on the colonisation of Marram by some aboveground invertebrate taxa. In a second field experiment, plants from genetically distinct populations of the local subspecies *arenaria* as well as the Mediterranean subspecies *arundinacea* are planted in a homogeneous landscape to investigate the effect of genotype on phenotype and the assembly of both belowground nematode communities and aboveground invertebrates. Finally, lab experiments are performed to disentangle the mechanisms of the interactions between belowground root herbivores (nematodes) and aboveground shoot herbivores (aphids) of Marram grass. In this presentation, we will report on the different operating mechanisms that influence both above- and belowground invertebrate communities.

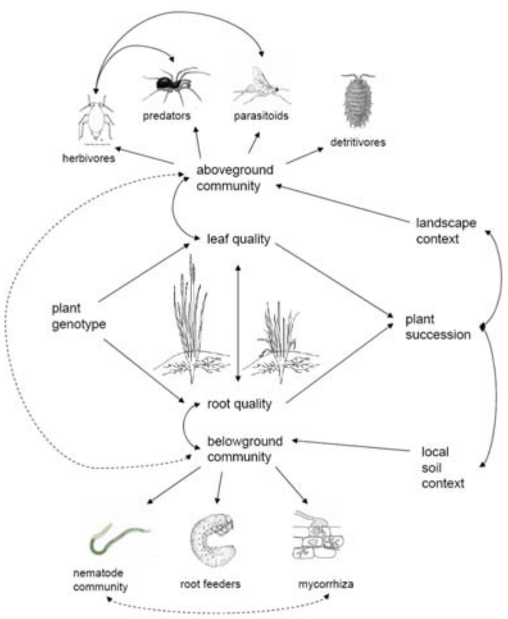

Figure 1: Some of the studied interactions in the Marram grass habitat (not a complete overview). Full arrows: direct interactions, dashed arrows: indirect interactions.

Poster presentations

Monitoring of invasive fish species in the upper part Kuibyshev water reservoir (Middle Volga, Russia): population penetration and establishment

Larisa Frolova
Kazan State University, Department of Zoology; Kremlevskaya Str. 18, 420008, Russia

Formation of ichthyofauna of the Kuybyshev water reservoir went on at direct and indirect anthropogenous influence. Numerous acclimatizations aiming at enrichment of Kuybyshev water reservoir fauna by valuable fodder and fishing objects (intentionally introduced mysids, mollusk *Monodacna colorata*, silver carp *Hypophthalmichthys molitrix*, grass carp *Ctenopharyngodon idella*) have led to parallel introduction of undesirable alien species (pipefish *Sygnathus nigrolineatus*, round goby *Neogobius melanostomus*, starry goby *Benthophilus stellatus*).

Although many fish species have invaded the water basin quite a long time ago, during 1957-1970, but 30 to 40 years were required to occupy suitable biotopes in the new reservoir, to create steady reproductively active populations quantitatively comparable to the main components of the reservoir's ichthyofauna.

All species invaders in the ichthyofauna of Kuybyshev water reservoir have short cycles of reproduction, plastic reproductive biology and feeding strategy and low selectivity in choosing of fodder objects. All of them have no trade value because of their small sizes.

Typical invaders in the ichthyofauna of Kuybyshev water reservoir are species from the Family Gobiidae round goby (*Neogobius melanostomus,* Pallas 1814), starry goby (*Benthophilus stellatus*, Sauvage, 1874) and tubenose goby (*Proterorhinus marmoratus,* Pallas, 1814). The first findings of round goby and starry goby in Kuibyshev water reservoir are going back to the beginning of 70-th of the last century. In 2003 one more species from the Gobiidae - tubenose gobies (*Proterorhinus marmoratus*) was found in Volgo-Kamsky stretch and in 2004 in Volga stretch of Kuibyshev water reservoir. In 2007 one specimen of *Neogobius gorlap Iljin*, 1949 were caught in Svijaga gulf of Kuibyshev water reservoir (Frolova, Galanin in press).

These small, not trade benthic fishes have successfully naturalized, widely spread, their populations are constantly growing.

Investigation of the diet of these species has shown that gobiids are feeding mainly on soft benthos. This is a reason for an active food competition with valuable fish species (a sterlet *Acipenser ruthenus*, carp bream *Abramis brama,* roach *Rutillus rutillus,* juvenile fishes of the majority of local species). On the other hand, there are data on active use of gobiids by local predatory fish species.

Thus, as a significant part of the reservoir ecosystem species invaders from the family Gobiidae cause redistribution of energy, biogens and pollutants flows, to structural and functional changes in food chains that can lead to the further changes in ecosystem of water basins.

Metacommunity theory approach on pool zooplankton communities of the Protected Landscape Area Kokořínsko (CZ)

Petr Jan Juračka & Adam Petrusek
Department of Ecology, Faculty of Science, Charles University, Viničná 7, Praha 2, 128 44
Czech Republic

We will present the application of a Metacommunity theory on data on zooplankton communities inhabiting newly created or re-established fishless pools of known age in Kokořínsko (Czech Republic). The pools vary in many basic environmental characteristics, such as size, age, water conductivity, macrophyte presence etc. We presume relatively low zooplankton dispersal rates in our system, because this region is specific by a low number of larger water bodies as a potential source habitats, and subsequently low density of waterfowl as important vectors of passively dispersing aquatic taxa. In such systems, species sorting is often supposed to be the most important applicable "metacommunity paradigm". The species sorting indeed seems to be relevant for our studied localities, according to fact that habitat age and year-season very strongly influence zooplankton species composition, while species richness in the patch is less influenced.

Additionally, we presume that under low propagule pressure, the effective distance to potential source habitats is important factor affecting community composition. We would like to test ratio of explained variation by spatial and environmental variables and to test mass effect, as well as patch dynamics paradigms to our data. We do not suppose neutral model to be relevant in this case.

The effect of shifting disturbance mosaic on a patchy Mediterranean shrubland

Manuel J. Pinto & Fernando Catarino
Botanic Garden, University of Lisbon, R. da Escola Politécnica, 54, 1250-102 Lisbon, Portugal

Assessment of communities assembly may depend not only on determinant environmental factors, dispersal and species competitive ability, but also on local and regional landscape history. In this study, landscape history is the succession of disturbance and recovery georeferenced events, relating cattle grazing and extensive farming, that have affected succession process and imprinted present shrubland vegetation. Local disturbance mosaics acted on a discontinuous habitat, formed by an archipelago of natural isolated rocky limy soils patches, scattered within a non-limy leached deep sand dunes.

We hypothesize that shifting disturbance is a high quality predictor for the assembly patterns found in present plant communities. Disturbance/recovery mosaics were assessed by remote detection on aerial photography registered at a 10 year lag since 1947. These mosaics have produced a second vegetation fragmentation level, embedded in the original soil patchiness. A shifting connectivity network then have progressively related local communities at several scales, however constrained by the scale of soil patchiness. How does the scale of fragmentation constrain the assembly patterns revealed in present shrubland metacommunities?

The interplay of relevant shrubland functional traits, was uncovered by statistically matching it with the top soil variables, mediated by disturbance across time. Shrubland communities manly formed by short-distance dispersive large resprouting perennials, have been formed in relatively undisturbed mosaics, associated to rich calcium locations. The assemblies of long-distance dispersive short-stem shrubs, are considerable more complex. In larger disturbed soil patches, higher levels of spatial autocorrelation characterize a larger number of species which have less diverse functional traits. We found that this relationship is intense when the scale of more persistent disturbance mosaics converges with the scale of soil patch.

Data regarding the alien / invasive species of Insecta, Nematoda and Acarina alien from Romania

Irina Teodorescu
Department of Systems Ecology and Sustainability/University of Bucharest

Our poster presentation is based on the preliminary results of an extensive and intensive investigation which is carried out since 2003, in order to identify the alien species of Insecta, Nematoda and Acarina and to assess their functional role and impact in or upon the communities and ecosystems where they have been established. The investigation was focused on a wide range of published and personal data concerning the first occurrence or introduction of the alien species, their dispersion on the Romanian territory, the dynamics of populations' abundance and recorded crops and forests damages, or the efficiency of some intentional introduced species in the biological pests control. Major findings of our investigation are reported as follows: i) From total 120 alien species, 98 are insects, 14 nematodes and 8 mites. Alien species of insects have been detected between 1864-1996, in different communities and ecosystems around the country (in crop fields, orchards, vineyards, greenhouses, warehouses, granaries, markets and homes). These belong to Coleoptera, Homoptera, Orthoptera, Blattaria, Thysanoptera, Heteroptera, Lepidoptera, Diptera and Hymenoptera orders, and to 47 families, most of species from Bruchidae, Diaspididae, Lecanidae, Curculionidae, Aleyrodidae and Eurytomidae. Between 1910 and 1988, the nematodes species, most of them belonging the Heteroderidae and Longydoridae families, have been non-intentionaly introduced and established, particularly in the vineyards and crop fields. Between 1913 and 1973, mites species, most of them from the Phytoptipalpidae family, have been established in greenhouses and vineyards. ii) From the total 120 alien species of insects, nematodes and mites, 106 are phytophagous (85 insects, 14 nematodes and 7 mites), 5 are vector and household (omnivorous or haematophagous) and 9 are useful (parasitoids, predators, silk worms, pollinators). iii)

The available data regarding dispersion, abundance and induced damages by the alien established species allowed for identification 51 invasive species, from which: 43 insects, 6 nematodes and 3 mites. The most invasive species of insects are pests for crops, vineyards and greenhouses, the invasive nematodes are pests for crops and vineyards and the invasive mites are pests in greenhouses and orchards. About 19 alien pest species (5 insects, 8 nematodes and 6 mites) have a high potential to become invasive. iv) The original ranges for alien species of insects are in Asia, America and Africa; for nematodes are in America and those of mites, in Asia and America. v) Despite of a rather limited number of alien insects and mites species which were intentionally introduced for economic reasons (silk production, biological pests control, pollination), most of them have been non/intentionally introduced. For some species it is assumed that the occurrence and establishment were the result of dispersal from neighboring countries, introduced with stored products or ornamental plants. The ongoing field researches are expected to bring new insights regarding the processes and mechanisms involved in the establishment of the alien species and their shift towards invasive behavior under fast and deep changes in the former or new drivers and pressures like land abandonment, re-structuring of the farming systems, changes in habitat connectivity, climate changes and globalization of the economic activities.

Biological invasion and dispersal mechanisms

3.3. From migration to invasion: Climate induced range shifts and biological invasions

Gian-Reto Walther, Alain Roques

Oral presentations

Plant range shifts and reduced enemy impact imply exotic invasion potential due to climate warming

T. Engelkes (1), E. Morrien (1), J.A. Harvey (1), T.M. Bezemer (1,2),K.J.F. Verhoeven, (1), A. Biere (1), W.L.M. Tamis (3) & W.H. van der Putten (1)
(1) Netherlands Institute of Ecology (NIOO-KNAW), 6666 ZG, Heteren, The Netherlands
(2) Wageningen UR, Lab. of Entomology, The Netherlands
(3) Nationaal Herbarium Nederland, The Netherlands

Ecosystems worldwide are increasingly being invaded by plants from exotic origin. It has been stressed that these invaders perform better than similar native species in the invaded communities. Although plant invasions have taken place for more than a century, the mechanisms explaining the success of invaders are not well understood yet. Considerable attention has been paid to the role of plant specific traits and natural control by aboveground herbivores, both in the original and new ranges of the invading plants.

Release from belowground or aboveground natural enemies has been widely stressed as the biggest advantage for invaders to become successful. These novel biotic interactions, if favorable, characterize these invasive plants by local dominance in their new community, thereby displacing native species, and strong dispersal reaching high abundances. Currently the consequences of climate warming are being noticed in range shifts of plants and animals to higher elevations and latitudes. Although biotic interactions strongly affect responses to warming, they are not included in climate studies. Hence, when plants spread faster than their natural enemies or than the enemies of their enemies, multi-trophic interactions can become, at least temporarily, disrupted. These changes in relations may create invasion opportunities for species within geographical regions. In order to understand how exotic plant species affect the soil microbial community and their aboveground enemies relative to that of native species we conducted a phylogenetically controlled experiment with cross comparison of plants grown in self conditioned soil and soil conditioned by other species. We investigated how exotic plants from warmer climatic regions within Eurasia respond to soil communities from an invaded ecosystem in North-Western Europe and to aboveground non-coevolved (desert locust (*Schistocerca gregaria*) and cosmopolitan generalist (green peach aphid *Myzus persicae*) shoot herbivores. Effects of range shifts of plant species within the continent were compared to exotic species originating from continents other than Eurasia.

We show that biomass of native plants was significantly negatively affected by their own soil community, whereas exotic plants, irrespective continental origin, experienced a neutral feedback effect. In addition we also found that the suitability of exotic plants towards the naïve locust was much lower than that of native plant species, while the cosmopolitan aphid performance was not affected by host origin. These results suggest that exotic species have been released from their enemies and resist novel enemy pressure both below –and aboveground. Since these effects were not different between Eurasian range expanders and exotics originating from other continents we conclude that climate warming could lead to biological invasions over continuous expanded ranges, influencing new encountered local ecosystem functioning.

Evolutionary responses influence establishment success of southern immigrants in the waterflea *Daphnia*

Wendy Van Doorslaer (1), Joost Vanoverbeke (1), Robby Stoks (1), Heidrun Feuchtmayr (2), Brian Moss (2) & Luc De Meester (1)
(1) University of Leuven, Laboratory of Aquatic Ecology and Evolutionary Biology, Ch. Deberiotstraat 32, 3000 Leuven, Belgium
(2) University of Liverpool, School of Biological Sciences, The Biosciences Building, Crown Street, Liverpool L69 7ZB, United Kingdom

The fate of many organisms confronted with the rapid rate of current Climate Change critically depends on their ability to track the shifting climatic conditions, either by migration or by local adaptation. Both processes are not only important for community assembly but also for population assembly within a species. The process of migration can lead to colonization of new habitats and displacement of local northern populations by immigrants from southern populations that are pre-adapted to higher temperatures. In contrast, the ability of populations to persist locally through rapid genetic adaptation may reduce the population's susceptibility to successful invasion by southern genotypes. Given the increasing number of reports on rapid evolutionary responses, these dynamics are increasingly recognized to potentially have important ecological consequences. However, despite its importance, this feedback from evolution to ecology has been unexplored experimentally in the context of Global Warming.

We conducted an outdoor competition experiment (Fig. 1) in which we compared the competitive strength between two sets of English resident *D. magna* clones (non-adapted to increased temperature and warm-adapted) and French immigrants. Our results showed a striking difference in competitive strength between non-adapted or warm-adapted residents when confronted with immigrants. Although French immigrants were the best competitors in all cases, resident warm-adapted clones were much better competitors than non-adapted resident clones. In natural situations where few immigrants have to compete with millions of residents this may make the difference between survival and extinction of the local population.

Figure 1: Experimental design. For this study, we capitalized on a large-scale experimental evolution set-up at the University of Liverpool. We installed 36 enclosures (7-liter) in a heated mesocosm.

Effects of climate change on the pine processionary moth range expansion: observations and predictions

Christelle Robinet (1), Alain Roques (1) & Andrea Battisti (2)
(1) INRA UR633, Forest Zoology, Av. de la Pomme de Pin, CS 40001Ardon, F-45075 Orléans, France
(2) University of Padova, DAAPV-Entomologia, Agripolis-Viale dell'Università 16, 35020 Legnaro, Italy

Climate change has already affected many plant and animal species. Their geographical range expanded or retracted depending on climatic tolerance, dispersal capabilities and response to environmental changes. During the last decades, the pine processionary moth (PPM), *Thaumetopoea pityocampa*, expanded northwards and upwards in Europe together with a significant increase in the mean minimum temperature in winter (Battisti *et al*. 2005). To determine the role of climate warming in this expansion, we conducted field and lab experiments, and we developed a predictive model using a climate scenario for the future.

We evidenced temperature as the driving factor of feeding activity of PPM larvae. To allow larval feeding, temperature inside the nest during the day should reach at least 9°C, and then air temperature during the following night should be above 0°C (Battisti *et al*. 2005). Understanding the mechanisms governing larval feeding activity is of particular interest because it may explain a large part of larval survival during winter.

Based on these results, we reconstructed PPM feeding activity in the past. We showed that although Paris and its close surrounding region was already favourable to the survival of PPM larvae in the 1990s, an unfavourable area located ca 50-70 km south of Paris prevented PPM expansion towards Paris until the 2000s, but then disappeared with the increase in winter temperatures (Robinet *et al*. 2007). By another way, a local population was discovered in eastern Paris, showing that human-mediated dispersal may exist.

Then, we described explicitly the expansion dynamics using a diffusion model coupled with an indicator of the feeding activity. We reconstructed successfully the range expansion in the southern Paris Basin since the 1980s. Under moderate hypotheses (IPCC climate scenario B2 and flying capability of 3 km), model predictions suggested a colonization of downtown Paris by 2025 (Robinet 2006). However, climatic anomalies such as the heat wave which occurred in August 2003 in Western Europe are likely to modulate such expansions because of contrasting effects: extremely high temperatures resulted in population collapse in the Paris Basin whereas range significantly expanded to higher elevations in the Italian Alps.

[1] Battisti A, Stastny M, Netherer S, Robinet C, Schopf A, Roques A & Larsson S (2005) Expansion of geographic range in the pine processionary moth caused by increased winter temperatures. *Ecol.Appl.*, 15:2084-2096.

[2] Robinet C (2006) Mathematical modelling of invasion processes in ecology: the pine processionary moth as a case study. PhD thesis, EHESS, Paris.

[3] Robinet C, Baier P, Pennerstorfer J, Schopf A & Roques A (2007) Modelling the effects of climate change on the pine processionary moth (*Thaumetopoea pityocampa* L.) expansion in France. *Global Ecology and Biogeography*, 16:460-471.

Bird migration as seasonally driven movement on a network

Andrea Kölzsch & Bernd Blasius
Mathematical Modelling, Institute for Chemistry and Biology of the Marine Environment (ICBM), University of Oldenburg, Postfach 2503, 26111 Oldenburg

The phenomenon of bird migration has recently raised a lot of attention because of the possible impact on humans by migratory birds transmitting diseases and the influences of global change on migration routes. The long-distance, annual migratory routes of several bird species can be described as a stepping stone model on a network of discrete breeding, resting and wintering sites.

We have modelled such a process of stepwise migration as an inhomogeneous Markov chain on a directed network of habitats. Each habitat is occupied by some density of birds during a certain time of the year and these nodes are connected by edges that represent the probability of jumping between the habitats. The jumping probabilities are considered to be periodic, unimodal functions of time, each parameterised with a characteristic phase φ and amplitude ω.

To examine the reasonability of our model we used real field observations, such as satellite telemetry data of e.g. the white stork (*Ciconia ciconia*) to parameterise our model. Each of the trajectories showed two modes of movement, slow resting movement and fast migration. The nodes of the network were determined by clustering the positions of slow movement, thus no habitat preferences or other biological information were needed.

With different methods of network analysis we then examined the dynamical properties of the generated network. We looked at several connectivity and resilience measures of the cumulative network and examined first passage times of the specified inhomogeneous Markov process. Results allow to characterise migration routes and give indications about the vulnerability of the examined migratory bird species to fragmentation, i.e. the loss of certain resting or breeding areas, and changes in the jumping phases due to climate change and habitat destruction. The network model can also be used to get an idea about the possibilities of epidemics spread and bioinvasion by migratory birds.

Because of its very general character, this migration model can be used for different species of long-distance migrants, as for example special biological characteristics can be accounted for in the data preprocessing. Features of preferred habitat could possibly be extracted afterwards from the identified resting areas. One may even take this model of seasonally driven movement out of the context of bird migration and apply it to any regularly driven, spatially explicit movement that shows different modes.

Climate-mediated spread of an introduced palm species. The role of germination and seedling survival

Silje Berger (1) & Gian-Reto Walther (2)
(1) Institute of Geobotany, Leibniz University of Hannover, Nienburger Str. 17, 30167 Hannover, Germany
(2) Department of Plant Ecology, University of Bayreuth, 95440 Bayreuth, Germany

Trachycarpus fortunei is a palm species native to Southeast-Asia. It is frequently cultivated in temperate regions all over the world, also in large parts of Europe, because of its cold-hardiness. Increasing winter temperatures allowed the palm species not only to survive outdoors as an ornamental plant beyond the natural poleward range limit of palms; it also started to spread from cultivation into surrounding forests at the southern foot of the Alps in southern Switzerland and northern Italy. Sub-spontaneous rejuvenation has also been observed in other parts of Europe. It was shown that critical climatic threshold values have been exceeded due to recent climate change, allowing *Trachycarpus fortunei* to naturalise, and additional regions where it might be able to survive in the near future were identified [1]. Germination and the juvenile phase are considered to be particularly vulnerable life stages, and hence critical for the establishment of perennial plants. Although adult *Trachycarpus fortunei* palms may resist temperatures as low as –14°C, successful survival of young saplings in the wild may require more favourable conditions. In order to test the ecological limits of *Trachycarpus fortunei* in the early life stage in the field, a large-scale germination experiment was installed using the ALARM Field Site Network [2]. Seeds of *Trachycarpus fortunei* were sown at 20 sites across Europe, from north Sweden to the Mediterranean region (Fig. 1). Germination and survival of *Trachycarpus fortunei* under field conditions in different bioclimatic regions of Europe was investigated during two field seasons.

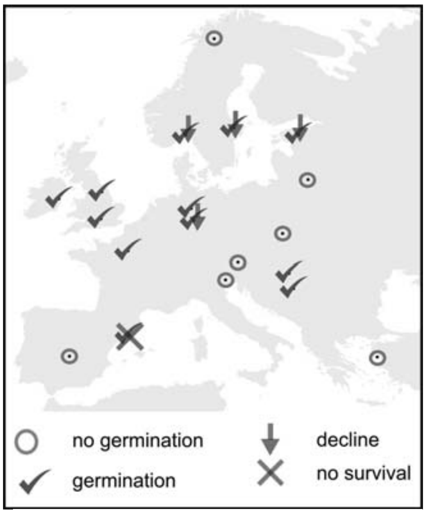

Fig. 1: Germination of *Trachycarpus fortunei* within the ALARM Field Site Network.

Germination is possible far beyond the areas where *Trachycarpus fortunei* is known to naturalise, and also beyond the modelled range, based on bioclimatic data from its native distribution. However, at many test sites climatic conditions do not allow the palm to grow up and establish, and seedlings experienced a phase of decline after the first winter. Higher seedling mortality was recorded towards the boundary of the area where germination was possible. Hence, seedling survival is a crucial stage in the establishment and invasion process of *Trachycarpus fortunei*. Parameters influencing germination success and seedling survival are discussed and related to further observations on the climatic limits of *Trachycarpus fortunei.*

[1] WALTHER, G.-R., GRITTI, E., HICKLER, T., BERGER, S., TANG, Z. & SYKES, M.T. (2007): Palms tracking climate change. *Global Ecology & Biogeography* 16: 801-809.
[2] SETTELE, J., HAMMEN, V., HULME, P., KARLSON, U., KLOTZ, S., *et al.* (2005): ALARM: Assessing Large-scale environmental Risks for biodiversity with tested Methods. *GAIA - Ecological Perspectives for Science and Society* 14: 69-72.

Baiting with alien: do local AM fungi colonize the roots of an alien plant?

Mari Moora (1), Silje Berger (2), Maarja Öpik (1), Gian-Reto Walther (2) & Martin Zobel (1)
(1) University of Tartu, Institute of Ecology & Earth Sciences, Lai 40, 51005, Tartu, Estonia
(2) Universität Hannover, Inst. Für Geobotanik, Nienburger Str. 17, 30167 Hannover, Hannover, Germany

Arbuscular mycorrhizal (AM) fungi (phylum Glomeromycota) are thought to be the oldest group of organisms living in symbiosis with land plants. AM fungi colonise the roots of most land plants, where they facilitate mineral nutrient uptake from the soil in exchange for plant-assimilated carbon. The present knowledge of AM fungal taxon distribution in plant roots is extremely scarce due to the fact that very few ecosystems in the Earth have been sampled. We lack information both from biodiversity hotspots of the world, as well as from several common zonal vegetation types.

We used the ALARM field site network (FSN) to evaluate site specific (soil & climate) effects on the germination and establishment of the alien plant species, *Trachycarpus fortunei* (Arecaceae). The origin of this palm species is in Southeast-Asia and the species is spreading in southern Switzerland and northern Italy. Rejuventation of this frequently planted ornamental species has also been observed in other European countries, e.g. in France. The setup of the transplantation experiment covers 20 experimental sites across Europe. We investigated the ability of indigenous communities of arbuscular mycorrhizal (AM) fungi to colonize roots of a non-native plant species in the 10 sites, where the species successfully germinated and grew. AM fungi inhabiting *T. fortunei* roots were identified using molecular methods: sequencing of SSU rRNA gene fragment utilizing the primer pair NS31-AM1. The potential of an indigenous AM fungal community to form symbiosis with an alien plant species is illustrated on the background of existent data from the Estonian FSN site at Koeru from where the molecular taxon list of AM fungi is available. Koeru spruce forest ecosystem distinguish by very high AM fungal taxon richness. 34 Glomeromycota taxa (SSU rDNA sequence groups) were detected from 90 root samples (911 clones), including eight new taxa.

Plant-microbe interactions in the rhizosphere of exotic thermophilic plants

Annelein Meisner (1), Elly Morriën (1), Wietse de Boer (2), George Kowalchuk (2,3) & Wim van der Putten (1,4)
(1) NIOO-KNAW, Centre for Terrestrial ecology, Multitrophic Interactions, P.O.Box 40, 6666 ZG Heteren, The Netherlands
(2) NIOO-KNAW, Centre for Terrestrial Ecology, Terrestrial Microbial Ecology, P.O.Box 40, 6666 ZG Heteren, The Netherlands
(3) Vrije Universiteit Amsterdam, Institute of Ecological Sciences, De Boelelaan 1085, 1081 HV, Amsterdam, The Netherlands
(4) Laboratory of Nematology, Wageningen University, PO Box 8123, 6700 ES Wageningen, The Netherlands

Temperature is expected to increase due to climate change, especially at higher latitudes. Therefore, thermophilic (warmth-loving) plant species are expected to extend their ranges from southern Europe towards the pole. Some such thermophilic exotic plants might become more abundant and even invasive in their new range, especially when they are released from natural enemies. Quite recently, the release from soil pathogens has been named as explanation for the invasion of exotic plants. However, an increased efficiency in nutrient acquisition might be another explanation for the increased abundance of exotic plants. In this study we examined how exotic thermophilic plant species acquire nutrients for growth and biomass production in comparison to their north-western European native congeneric plants. A greenhouse study was conducted comparing the effects of exotic thermophilic plants and native congeneric plants on soil processes related to nitrogen and phosphorus cycling. We observed that exotic plants altered nitrogen cycling, but that the direction of this alteration was different among congeneric plant couples. On the other hand exotic plants inhibited phosphorus cycle less than the native congeneric plants. We propose that the effects of exotic thermophilic plants on soil microbial communities in their new range depend on the plant species investigated. Altered nutrient cycling may play a role in enhanced plant performance, but certainly not in all cases.

From migration to invasion – a challenge for conservation and ecosystem management

Gian-Reto Walther
University of Bayreuth, Department of Plant Ecology; 95440 Bayreuth, Germany

Climate change and biological invasions are important drivers affecting global biodiversity. Alterations to climate result in changes to native distributions thereby providing alien species with opportunities for expansion. Climate change seems to play an important role in facilitating colonisation and establishment of introduced species and presents new opportunities to find suitable habitats beyond their native distribution range.

With continued climate change and the resulting increasing migration distances, it becomes increasingly difficult to separate natural migration processes from human-mediated invasions, especially when species originate from the same continent or adjacent regions, but their transfer to the new habitat might have profited from human assistance.

The expected mixed assemblages of native and non-native species (Fig. 1) raise important questions about which invasive species to tackle and which ones to ignore. Invasive species that are chosen to control at present, might become acceptable or even desired species at some sites in the future in order to assure local ecosystem functions and services.

Case studies of climate-induced range shifts and climatically triggered biological invasions are presented and discussed with respect to the challenge they entail for conservation and ecosystem management.

Figure 1: A community of expanding native, immigrating neighbouring, and spreading introduced evergreen broad-leaved species in a deciduous forest at the southern foot of the Alps.

Poster presentations

Germination and seedling establishment of exotic *Fallopia*-taxa along a climate gradient

Christine Krebs (1), Marco Moretti (3), Urs Schaffner (2) & Diethart Matthies (1)
(1) Philipps University of Marburg, Karl- von Frisch Strasse 8, 35032 Marburg, Germany
(2) CABI Europe-Switzerland Centre, Rue des Grillons 1, 2800 Delémont, Switzerland
(3) Swiss Federal Research Institute WSL, Via Belsoggiorno 22, 6504 Bellinzona, Switzerland

Exotic knotweeds (*Fallopia japonica,* also referred to as *Polygonum cuspidatum* and *Reynoutria japonica*, *Fallopia* (*Reynoutria*) *sachalinensis* as well as their hybrid, *Fallopia* (*Reynoutria*) x *bohemica*) are considered to be among the most serious invasive exotic weeds in Europe. The taxa are thought to reproduce mainly asexually in Europe. There is growing evidence that sexual reproduction also occurs in the introduced range. In addition, the different *Fallopia* taxa are able to hybridize. Viable seeds have been recorded from various *Fallopia* sp., though seedlings are rarely observed in the field. Lack of observed seedlings may be due to lack of pollen and low rates of seedling establishment. Seedlings of *Fallopia* may be sensitive to frost and will not survive a winter. Increasing temperatures may lead to greater rates of seedling establishment. Frequent sexual events and hybridization could increase the genetic variability and this could lead to an increase of the invasiveness of the *Fallopia* taxa.

A germination experiment was set up along a climatic gradient to test the impact of climatic factors on germination and seedling establishment of exotic *Fallopia* spp. in Europe. Seeds of *F. japonica*, *F. sachalinensis* and of the hybrid *F.* x *bohemica* were collected in several regions in Germany, Switzerland and Belgium. In November 2006, seeds were placed in pots in common gardens at six different locations along a gradient from northern Germany to southern Switzerland. The climatic conditions at the southern most location are similar to the future climate predicted for large parts of Germany, i.e. with higher temperatures and annual rainfall.

Preliminary analyses indicate that germination differed significantly between locations and was lowest at the northernmost and at the most elevated location. Height, leaf length and leaf width of seedlings differed significantly between taxa and locations. Smallest values of morphological parameters were recorded for plants growing at the most elevated site, and highest values for plants growing at the most southern site. The results also indicate that *Fallopia* seedlings are able to survive the winter.

Direct responses to temperature increase in alien vs. congeneric native species

Maya Verlinden & Ivan Nijs
Research Group Plant and Vegetation Ecology, Department of Biology, University of Antwerp, Universiteitsplein 1, B-2610 Wilrijk, Belgium

Future invaders will not experience the climate of today. In temperate regions by 2050, winters are projected to be milder and summers hotter, and precipitation events less frequent but more intense. There are several reasons to believe that invasive plant species will react differently to such changes than their native counterparts. Alien species often exhibit a greater plasticity in their respons to changes and disturbances in the environment. They may have a greater capacity to shift the physiological optimum to a range that is favourable in the new climate. Furthermore, alien species, especially those originating from regions with a warmer climate, may be closer to optimal physiological functioning under elevated than under ambient temperatures, which may enhance their future competitiveness relative to natives. Climate warming could therefore be, on the one hand, a trigger for many 'slumbering' alien species that are currently part of the flora without expanding, and rising temperatures may on the other hand strengthen the invasive potential of many alien species that are already invasive.

An experiment was set up to examine the responses of native vs. alien species to an experimentally induced temperature increase. We studied the direct effect of an increase in temperature on growth and productivity. Ten congeneric species pairs (each pair consisting of 1 alien species and 1 closely related native counterpart) were used, varying in invasiveness, and originate from regions varying in climate. In addition to invasive alien species we also included (currently) non-invasive aliens, which are considered future high risk species if they are highly responsive to warming. Single plants were exposed to ambient and elevated temperature (+3 °C) in small climate-controlled greenhouses. The species were screened for some morphological and ecophysiological plant characteristics and processes, which are known from the literature to be potentially related to differences in growth and productivity.

We analyzed whether, within the whole set of species pairs, the alien species systematically responded differently than their native counterparts to an increase in temperature and whether the changes that are observed potentially enhance invasiveness. Our results show that alien and native plant species responded differently to warming, with most alien species benefitting from a warmer climate whereas native species were adversely affected.

Modeling Spatial Patterns and Dynamics of Alien Plant Invaders in Agro-Forestry Landscapes

Joana Vicente (1,2), Paulo Alves (1,2), Antoine Guisan (3), Christophe Randin (3,4), Angela Lomba (1,2) & João Honrado (1,2)
(1) CIBIO – Centro de Investigação em Biodiversidade e Recursos Genéticos, Portugal
(2) Faculdade de Ciências da Universidade do Porto, Portugal
(3) Spatial Ecology Group, Département d'écologie et évolution, Université de Lausanne, Switzerland
(4) Institute of Arctic and Alpine Research, University of Colorado at Boulder, USA

Biological invasions constitute the second threat to biodiversity around the world after habitat destruction. With plant species of Europe invading other continents and vice-versa, a process of "globalization of vegetation" is going on. Therefore, anticipating future invasions is a major task in conservation biology, and species distribution models (SDM) are useful tools in this regard. Here, we use a hierarchic modelling framework to: (i) understand the ecological constraints of alien plants and how they respond to environmental changes in agro-forestry landscapes, and (ii) to predict the current and future distribution for four alien tree and shrub species in the extreme Northwest area of Portugal. Ultimately, we intend to assess possible synergetic effects of climate and land use change on alien plant occurrence and dynamics.

Figure 1: Study area (a) and its location in Iberian Peninsula (b) and in Europe (c).

We use *Acacia longifolia*, *Acacia dealbata*, *Acacia melanoxilon* and *Hakea sericea* as model species. These species invade several natural habitats, but are more common in forest stands and agro-forestry landscapes characterized by intermediate levels of agricultural intensity. This study provides the theoretical framework for modelling invasion patterns in Mediterranean system and for supporting eradication strategies, by predicting the future occurrence and spread of these problematic alien species, under present and future climate and land-use change scenarios.

Biological invasion and dispersal mechanisms

3.4. Mechanisms behind species invasions: Searching for generalizations across scales and taxa

Sylvia Haider, Tina Heger, Maike Isermann, Jonathan M. Jeschke, Ralph O. Schill

Oral presentations

The nature and mechanism of interference of invasive weed *Eupatorium odoratum*

Harminder Pal Singh (1), Shalinder Kaur (2), Sunil Mittal (1), & R.K. Kohli (1,2)
(1) Centre for Environment and Vocational Studies,(2) Department of Botany, Panjab University, Chandigarh – 160014, India

Eupatorium odoratum L. (=*Chromolaena odorata* (L.) King & Robinson; family Asteraceae), commonly known as Siam weed, Chromolaena, bitter bush, and triffid weed, is an invasive weed native of tropical America and is now listed among the top 100 invasive species by the Global Invasive Species Database (GISD). It was probably introduced to India as an ornamental plant and acquired weedy habit later on. In India, it is a major weed of north-eastern and southern areas, including Western Ghats, where it interferes with coconut, rubber, coffee and teak plantations. Of late, the weed has started invading the Northwestern Himalayas particularly, in Shiwaliks hills, at an alarming rate. It has already occupied favourable habitats / niches and formed its own monocultures at the expanse of native flora. However, very little is known about the exact nature and mechanism of interference of this weed that enables it to successfully colonize the invaded habitats. Recently, chemical-mediated interference (allelopathy) has been postulated as one of the novel mechanism of invasion by alien weed species. We therefore conducted a series of laboratory and screenhouse experiments to understand the nature and mechanism of interference of *E. odoratum*. For this, the soil previously not infested with the weed was amended with different amounts of *E. odoratum* residues with a view to determine phytotoxic effects on other plants vis-à-vis changes in soil chemistry and phenolic content. Growth studies conducted in the laboratory as well as under green house conditions indicate inhibitory effect of the residues amended in soil on the growth and establishment of native species *Cassia occidentalis*. Furthermore, the growth and establishment of the test plants was greatly reduced in the soil amended with residue extracts. Even the addition of activated charcoal that has a great affinity for organic inhibitory molecules (allelochemicals) or nitrogen supplementation could not fully ameliorate the growth inhibition in residue amended soils. Further, the residues did not reduce the available nutrients in the soil, which was rather nutrient rich. These results indicated a definite role of allelopathy of *E. odoratum* in the soil medium. In contrast, the amended soils contained significantly higher amount of phenolics indicating their possible involvement in the growth inhibitory effects and their interactions with soil chemical properties. This further gets confirmed from strong correlation between phenolics and various soil properties. The study, therefore, concludes that *E. odoratum* affects the growth and establishment of other plants by releasing phytotoxic phenolics into the immediate soil environment and interfering with soil chemistry.

Density and growth of *Rosa rubiginosa* L.; invasive in Argentina and declining in Europe

Heike Zimmermann (1), Daniel Renison (2), Maria Damascos (3), Erik Welk (1), Karsten Wesche (1) & Isabell Hensen (1)
(1) Martin-Luther-University Halle-Wittenberg, Department of Geobotany and Botanical Garden, Am Kirchtor1, 06108 Halle, Germany,
(2) National University of Córdoba, Department of Ecology, Av. Velez Sarsfield 299, 5000 Córdoba, Argentina
(3) National University of Comahue, Department of Ecology, Quintral 1250, 8400 San Carlos de Bariloche, Argentina

Rosa rubiginosa L. shrubs in Argentina outgrow their European ancestors in both number and size, a phenomenon already described for numerous invasive species. We used a hierarchical linear mixed model (LMM) approach in order to analyse the cover of *R. rubiginosa* on 50 x 50 m plots at population (n=28), regional (n=4) and continental scale (n=2). On the regional scale we pooled populations in Central Argentina, Southern Argentina, Spain and Germany, while on the continental scale populations were pooled in Argentina and Europe respectively. Regarding *R. rubiginosa* cover, 68% of the variance in the dataset was at the continental level, 20% at the regional level and 12% at the population level; thus, populations in Argentina indeed cover larger areas than in Europe. However, *R. rubiginosa* is more abundant in Southern Argentina than in Central Argentina, which may be due to a shorter colonization history in the latter region. Furthermore, using a LMM we analysed the response of *R. rubiginosa* cover to standard climatic variables, which were derived from the worldclim dataset [1]: In Argentina mean annual temperatures are higher and vegetation receives almost double the amount of annual rainfall than that of Germany or Spain. Although annual mean temperature, minimum temperature of the coldest month and precipitation seasonality significantly explained *R. rubiginosa* cover ($p<0.05$), climatic variables explained 0% at the continental level, 32% at the regional level and 68% at the population level. The extreme climatic gradient on the population level was confirmed by an autocorrelation test using correlograms. Therefore, climate should not be expected to account for the higher coverage on the continental scale described above.

Similarly, annual growth rates (2006-2008) of branch lengths of randomly marked shrubs from our studied populations could not be explained by climatic variables, and *R. rubiginosa* growth rates in Argentina did not exceed European growth rates. Nonetheless, our growth rate measurements revealed a potential explanation for the greater population sizes in the invasive range: In contrast to Argentina, 22% of all *R. rubiginosa* shrubs marked in Europe were either cutback or completely removed. Within the old cultural landscape of Europe, suitable *R. rubiginosa* habitat is limited to a few protected areas, where it is cut in order to promote plant biodiversity.

We will discuss our findings in the context of reciprocal common garden experiments as well as of assessments of population age structure.

[1] Hijmans RJ, Cameron SE, Parra JL, Jones PG, Jarvis A (2005) Very high resolution interpolated climate surfaces for global land areas. International Journal of Climatology 25 (15): 1965-1978

Digging in the dirt: Underground mechanisms of exotic plant invasions

Susana Rodríguez-Echeverría, João A. Crisóstomo, Cristina Nabais & Helena Freitas
Centre for Functional Ecology. Department of Botany. University of Coimbra. 3000-455. Coimbra. Portugal

Plant-soil interactions can explain vegetation patchiness in an ecosystem and the progress of plant invasion. This statement is particularly accurate for leguminous species that largely depend on symbioses with nitrogen-fixing bacteria, collectively known as rhizobia, to establish and grow successfully. Biological nitrogen fixation is also a P-demanding process, so most legumes are also highly dependent on P-supply by arbuscular mycorrhizal fungi (AMF) in natural ecosystems.

Although legumes are, in general, poorer colonizers than most flowering plants, some leguminous species are among the most aggressive invaders worldwide. Access to compatible soil mutualists is probably the most critical factor determining the colonizing ability of legumes. Therefore, invasive legumes are likely to have specific mechanisms to facilitate the establishment of effective symbioses in new soils, such as a low symbiotic specificity or the ability to establish symbiosis at low microbial densities. In spite of all this, the ability of invasive legumes to recruit belowground mutualists in new areas and the putative relationship between nodulation and their invasive potential is not very well understood.

This study aims to clarify the importance of these belowground mutualisms for the invasive ability of the Australian woody legume *Acacia longifolia* (Andrews) Will. We compared the interaction with soil mutualists and their effect for plant growth in this invasive species and two native woody legumes, *Cytisus grandiflorus* (Brot.) DC. and *Ulex europaeus* L., which co-exist in the Natural Reserve of São Jacinto (NRSJ), a protected coastal area in Portugal. *Acacia longifolia* was introduced into this area in the beginning of the 20th century during several reforestation projects for dune stabilisation and timber production. As a result of the plantations and the quick establishment of *A. longifolia*, the inter-dune slack and the secondary dunes are now primarily covered by this exotic legume. Monospecific patches of the native species can be found closely associated with the invasive species in the secondary dunes but they rarely form mixed stands.

Seedlings of the invasive *A. longifolia* and the natives *U. europaeus* and *C. grandiflorus* were planted in five soil types representing the most abundant vegetation types in the studied coastal dune system. Significant differences in the number of nodules produced per plant, final plant biomass and shoot ^{15}N content were detected between the three woody legumes. There was a correlation between the number of nodules produced, shoot ^{15}N content and the area occupied by each species. *Acacia longifolia* also displayed a lower phenotypic plasticity than the two native legumes which resulted in a greater allocation to aboveground biomass in the soils with lower nutrient content. We conclude that the invasive success of *A. longifolia* is correlated to its capacity to nodulate profusely and to use the biologically-fixed nitrogen to enhance growth aboveground in soils with low N content. This ability allows *A. longifolia* to grow and spread quickly, thereby overshading the seedlings of other native species.

Limiting similarity influences experimental grassland invasion and assembly: but is it phylogenetic or trait-based similarity?

Alexander J. F. Fergus, Jana S. Petermann, Lindsay A. Turnbull & Bernhard Schmid
Institute of Environmental Sciences, University of Zürich, Winterthurerstrasse 190, CH-8057 Zürich, Switzerland

Plant community invasibility describes a community's susceptibility to colonization by individuals of non-resident species. Invasion resistance of community residents, an opposite measure of susceptibility, has been shown to be related to the degree of niche overlap between resident species and invaders. Functionally diverse communities should have a higher resistance to invaders due to increased resource pre-emption resulting from greater niche differentiation/complementarity. Niche-based theory therefore predicts that community invasibility should decrease if a potential invader is functionally similar to a resident; this is akin to the limiting similarity the assembly rule of MacArthur and Levins (1967). Limiting similarity stipulates that there will be stronger competition between species more similar in their functional traits and resource use. We wanted to identify factors that determine how easily a particular community can be invaded by a non-resident species. Our expectation was that invader success would be positively correlated with functional differences to residents and therefore higher if they belonged to a functional group which was already present as a community resident. We added seeds into established communities of monocultures and three-species mixtures, where a particular functional group was already among the residents ("home"), or not ("away"). Our resident communities derived from 48 species common to European grasslands and belonging to three functional groups: grasses, forbs, and legumes.

Invader biomass was on average more than double that in the "away" plots (3.66 g) versus "home" plots (1.55 g), and this was consistent for both monocultures and three-species mixtures. Seven out of eight legume and 13 out of 16 grass species were more productive as invaders in "away" communities, compared to only ten out of 22 forb species. Legumes on average produced four times more biomass in "away" communities, and grasses almost double. The mixed forb response was likely because of too much functional variation related to the eight families it comprised, versus the single families for the grass and legume functional groups. This indicates that commonly-used functional groups may not be better than taxonomic groups in predicting niche overlap. By comparing functional diversity taken from a matrix of trait values against phylogenetic distance, we can comment on whether this dissimilar invader success is mostly due to trait based processes or phylogenetic relationships. This comparison also permits us insight into phylogenetic niche conservatism, the tendency of species to retain aspects of their fundamental niche over time. Our results show that species dissimilarity and thus niche complementarity represent a strong structuring process during plant community assembly, consequently, community invasibility increases with invader functional dissimilarity, supporting the operation of limiting similarity in grasslands.

Less lineages – more aliens: Phylogenetically clustered plant communities are more open to exotic species

Andreas Prinzing (1), Pille Gerholdé (2), Meelis Pärtel (2), Stephan Hennekens (3), Joop Schaminée (3) & Igor Bartish (1)
(1) University of Rennes , Unit Ecobio; Campus Beaulieu, Bâtiment 14, 3502 Rennes; France;
(2) Institute of Ecology and Earth Sciences, University of Tartu, Lai 40, Tartu 5100; Estonia;
(3) Alterra, WUR, PO Box 47, NL-6700 AA Wageningen, NL

Immigrations of species into indigenous communities are a major thread to biodiversity but it remains unclear why some types of communities are heavily affected and others hardly. We hypothesize this may reflect differences in the evolutionary history of different types of communities. Some types of plant communities are dominated by a single evolutionary radiation into a given environment with most species coming from the same lineage, other types of communities were open to the immigration from many evolutionary lineages, each contributing only few species. Here we test whether openness to many lineages (i.e. phylogenetic overdispersion) throughout evolution increases or decreases openness to aliens today. We analyze plant associations across The Netherlands. We quantify the average proportion of alien species in local plots and correlate it against the phylogenetic dispersion of the incumbent species in local plots not yet colonized by alien species. We find that the phylogenetically overdispersed associations have significantly lower percentages of aliens than phylogenetically clustered associations. The effect of phylogenetic dispersion is at least as strong as that of the number of incumbent species and their clade rank or mean of various ecological requirements. We conclude that immigration and filling of niche space in the evolutionary past may render communities resistant to aliens today, whereas community types that were isolated from immigration in the past may be “naïve” and easily invasible today. Until now, such mechanisms had been invoked only at the scale of oceanic islands.

Vulnerability profile of ground-nesting waterfowl following introduction of American mink on Navarino Island, Cape Horn Biosphere Reserve, Chile

Elke Schüttler(1,2,3), Reinhard Klenke (1,4), Steven McGehee (2,5), Ricardo Rozzi (2,6) & Kurt Jax (1,2,3)
(1) Department of Conservation Biology, Helmholtz Centre for Environmental Research-UFZ, Permoserstr. 15, 04318 Leipzig, Germany
(2) Omora Ethnobotanical Park (Institute of Ecology and Biodiversity, IEB, Universidad de Magallanes, and Omora Foundation), Puerto Williams, Antarctic Province, Chile
(3) Department of Landscape Ecology, Technische Universität München-Weihenstephan, Am Hochanger 6, 85350 Freising, Germany
(4) Society for Nature Conservation and Landscape Ecology, Dorfstr. 31, 17237 Kratzeburg, Germany
(5) Department of Biology, University of Victoria, PO Box 3020,Victoria, B.C. Canada V8W 3N5
(6) Department of Philosophy, University of North Texas, Denton, U.S. TX 76201

Biological invasions constitute one of the most important threats to biodiversity. This is especially true for native “naïve” birds in island ecosystems that have evolved in the absence of terrestrial predators. The American mink (*Mustela vison*) recently established a feral population on Navarino Island (55°S), southern Chile, an island that was previously free of terrestrial mammal predators. We investigated the impact of mink on ground-nesting coastal waterfowl with the aim to derive a vulnerability profile for birds as a function of different breeding strategies, habitat and nest characteristics. We compared Mayfield survival and mink predation rates of 102 nests of endemic single-nesting species (*Chloephaga picta*, *Tachyeres pteneres*), of 361 nests of colonial birds (*Larus dominicanus*, *Larus scoresbii, Sterna hirundinacea*) and of 558 artificial nests. We estimated relative mink and bird densities at all nest sites. Nests of colonial species showed highest nest survival probabilities (58-80%) and no predation by mink. For single-nesting species nest survival rates were lower and mink predation rates were higher: 15% were successful nests and 10% were predated nests by mink for upland geese (*C. picta*); 5%, and 43%, respectively, for flightless steamer ducks (*T. pteneres*). Artificial nests all most completely failed (0.4%) with an overall mink predation rate of 17%. Multivariate analyses of predatory patterns of the introduced mink versus autochthonous predacious birds (principal component analyses, discriminant analyses, and procrustes analyses) revealed that mink predated artificial nests mainly at shores with rocky outcrop where relative mink densities were significantly higher than at beaches. High nest concealment increased the probability for predation by mink as it was the case for nests of flightless steamer ducks which show higher concealment than nests of upland geese. We conclude that introduced mink might severely affect the reproduction success of bird species with the following characteristics: single-nesting, nesting habitat at coastal shores with rocky outcrop, and high nest concealment. This vulnerability profile fully corresponds with the nesting behaviour of the flightless steamer duck, a species that is endemic to southern South America.

Do extrinsic or intrinsic factors afford invertebrate invasions? A case study in Canarian laurel forests

Erik Arndt (1) & Jörg Perner (2)
(1) Anhalt University of Applied Sciences, Department LOEL, Strenzfelder Allee 28, D-06406 Bernburg, Germany. E-mail: earndt@loel.hs-anhalt.de
(2) U.A.S. Umwelt- und Agrarstudien GmbH, Ilmstraße 6, D-07743 Jena, Germany. E-mail: j.perner@uas-jena.de

We studied the ground dwelling invertebrate fauna in laurel forests of the three western Canary Islands using two sample techniques (soil samples and pitfall traps). Four different functional groups of arthropods comprising two carnivorous and two detritovorous groups were examined: Carnivorous ground dwelling beetles (Carabidae + Staphylinidae); Chilopoda; Diplopoda; Isopoda (Oniscoidea). A large proportion of invasives (species and individuals) was observed in all of the studied arthropod groups except carnivorous ground dwelling beetles. Patterns of invasion were analysed testing diversity, niche occupation, 'disturbance parameters' and 'climate parameters'. Indicators of secondary forests (e.g. coverage of *Erica arborea*) and age of trees were used as surrogates for the degree of disturbance. The potential direct solar insolation, altitude of sites (between 600-1350 m), cover of tree and forb layer as well as the extent of litter layer were considered to be important parameters affecting the above ground climate and therefore used as surrogates for 'climate parameters'.

We did not find any support for the Diversity-invasibility-hypothesis (DIH) based on the examined arthropod groups. A significant correlation between species numbers of native and invasive species occurred in Chilopoda only. However, this was a positive correlation ($r = 0.467$, $p<0.05$) and therefore would contradict the DIH. Two reasons may be responsible for the fail of the DIH in our study. (I) The species numbers in the different ecological groups might be too low and this relation might be covered by stochastic effects. The observed species numbers per site and group varied between 1 and 9, with 4 in average. These species numbers were much lower than those in studies of the plant communities supporting the DIH. (II) The second reason could be a stronger influence of extrinsic factors which covary with the diversity of native or invasive species. Regarding the impact of the extrinsic factors 'disturbance' and 'climate' on invasion patterns, we found considerable differences between the studied functional groups. Whereas the 'disturbance parameters' played a minor role and affected only the relative abundances of invasive Chilopoda (positively) and Diplopoda (negatively), the 'climate parameters' were significantly linked with the pattern of invasive detritivores. Abundances and species numbers of invasive Diplopoda as well as abundances of invasive isopods increased significantly with decreasing altitude or/and increasing insolation (PDSI). These results give some evidence that the invasion pattern of taxa or functional groups may also be significantly controlled by climatic factors. The tree layer is the second important factor determining the distribution pattern of Diplopoda and Isopoda in the examined habitat type. A dense tree layer with *Laurus novocanariensis* and other natural broad-leaved trees can be interpreted as suitable trophic base for detritovorous groups. Therefore trophic and climatic factors seem to be more important for invasion or distribution of millipedes and isopods than parameters of disturbance.

Abstract too long/cut

South American exotic mammals as model organisms for ecological understanding

Ricardo A. Ojeda, Agustina Novillo & Fernanda Cuevas
Grupo de Investigaciones de la Biodiversidad, Institute for Aridlands Research (IADIZA) and Ntnl Council for Sci & Tech of Argentina (CONICET);Parque San Martín, 5500 Mendoza, Argentina; rojeda@lab.cricyt.edu.ar

Biological invasions, climate change, habitat fragmentation and wildlife commercialization are among the leading threats to global biodiversity. On the other hand, species invasions are like natural experiments that offer opportunities for research on several ecological and evolutionary aspects. The exotic mammals of South America represent about 20% of world mammal introductions. The aim of this presentation is to provide an overview of the mammal invaders of Argentina, their attributes as invasive species and potential role as model organisms for ecological understanding.

Nineteen introduced mammal species (excluding domestics) are present in southern South America. Among these, 18 species (the majority of them natural from Eurasia), represent 5% of the terrestrial native mammals of Argentina. The majority of introductions occurred between the 18th and 19th centuries. Their ports of entry were mainly located in the temperate eco-regions (34º to 55º SL), and mostly associated with human activities (e.g., sport hunting, food and fur industry purposes). Some of the attributes suggested for their success are their wide geographic ranges, broad herbivorous and omnivorous diet, no ecological counterparts, generalists in habitat use and a predator- free environment. High invasive potential corresponds to wild boar, red deer, goat, european hare, and old world rats, whereas low values were recorded for the red squirrel, antilope and axis deer. Exotic mammals occupy similar eco-regions as in their original distributions, but most of them have experienced a range expansion to novel habitats. The highest density of exotic mammals is found in the temperate eco-regions, and in some places species richness of exotics is higher than that of natives (5). Several topics to be explored are their genetic diversity in relation to small founder populations, ecological role of keystone species/ecosystem engineers (e.g. wild boar, beaver), coexistence and interactions among potential ecological counterparts (e.g. native and exotic medium sized herbivores), rates of dispersal of recent invaders (e.g. squirrel), their role in plant and animal communities, seed dispersal and seed predation, among others. In conclusion, the exotic mammals of Argentina represents a rich diversity of macroniches and a good opportunity for research on ecological and evolutionary processes (*Partially funded by ALARM project, EU, CONICET and Agencia- SECYT, Argentina)*.

Multiple threats to species - co-occurrence of non-indigenous species with other major threats

Helena Berglund, Göran Bengtsson & Johannes Järemo
Lund University, Department of Ecology; Sölvegatan 37, 22362Lund, Sweden

The causes of species declines and extinctions are often multi-factorial, and for particular species, the different kinds of threats are often well known. For example, insular birds species may simultaneously be exposed to habitat alteration, overexploitation, and non-indigenous species (NIS). Here we test whether the threat from NIS co-occur purely randomly with other threats. We used the IUCN red list to gather information on mammals threatened by NIS and nine other major threats listed in the database (habitat loss, harvesting, accidental mortality, persecution, pollution, natural disasters, changes in native species dynamics, intrinsic factors and human disturbance). The data were used to develop a model in which species were sampled under the assumption of random co-occurrence of NIS and other threats. The model was implemented by Monte Carlo simulation, and the resulting probability distributions were compared with the degree of co-occurrence of threats calculated from the database. The tests showed that NIS generally co-occurred with other threats to a larger extent than predicted from the random model. The combination of NIS and intrinsic factors was an exception because they co-occur randomly. The comparison suggests that the red list species affected by other threats than intrinsic factors are more likely threatened by NIS.

Are we starting to face a "Homogocene"? - Homogenization patterns between Europe and North America

Marten Winter (1), Ingolf Kühn (1), Frank LaSorte (2), Oliver Schweiger (1), Wolfgang Nentwig (3) & Stefan Klotz (1)
(1) Helmholtz Centre for Environmental Research – UFZ, Department of Community Ecology
(2) Ecology, Behavior and Evolution Section, Biological Sciences, University of California, San Diego
(3) Community Ecology, Zoological Institute, University of Bern
corresponding author: marten.winter@ufz.de

Widespread introduced species tend to increase the similarity of biotas across the world. This phenomenon of biotic homogenization has been reported for different regions, geographical scales and organisms. However, only few studies so far addressed homogenization on continental and global scales. Therefore, we analysed homogenization patterns of plants and vertebrates within and between the European and North American continents while controlling for climatic differences and geographic distance.

We found that, except for plants in Europe, alien plants and vertebrates lead to homogenization within North America and Europe and between the continents. Our results show that: (i) widespread species that are aliens to both continents and (ii) species exchanged between continents lead to global homogenization. Possible underlying causes for differentiation effect of alien plant species in Europe, such as human settlement history and the role of archaeophytes (aliens introduced before 1500 AD) will be discussed.

Alien species in a hotter world: will human disturbance make a difference?

Chiara Polce (1), William E. Kunin (1), Jacobus C. Biesmeijer (1), Jens Dauber (1) & the ALARM Field Site Network
(1) University of Leeds, Institute of Integrative and Comparative Biology, Clarendon Way, Leeds LS2 9JT, United Kingdom

Biological invasions are considered amongst the greatest threats to biodiversity [1]. Although not all introduced species become invasive, there is evidence that changes in climate might promote the expansion of alien species [2]. Any landscape includes a wide range of microclimates, each of which may favour different sets of plant species. In the face of climate warming, the warmest microsites within any landscape will be most likely to have moved out of what had historically been the local "climate space." Thus local species populations may be relatively poorly adapted to these sites, potentially making their communities most invasible. In addition, it seems that disturbed, anthropogenic habitats are more invasible than intact natural communities [3], which means that the proportion of such habitats in the landscape may in turn affect its invasibility. Therefore we expect warmer sites and disturbed landscapes to host higher alien occurrence.

We used the field sites network (FSN) established within the frame of the EU FP6 project ALARM, to measure alien plant species richness and cover in matched samples of semi-natural and anthropogenic habitats, chosen to represent the hottest, intermediate and coldest microsites within each focal landscape. The FSN network is characterized by paired landscapes with contrasting proportions of comparable habitats, distributed across Europe. We modelled potential annual mean temperature based on Digital Elevation Models, using tested and empirical spatial algorithms. We recorded plant species at each selected microsite, using transects of point samples to quantify cover at each microsite. This allowed us to obtain a quantitative measure of the alien and the native density and diversity.

Our preliminary results showed that microclimatic differences strongly affect alien occurrence, but that these effects are not consistent across sites; furthermore, we found evidence of positive correlation between human disturbance and alien occurrence at the habitat scale. We will present our methodological and analytical approach, and we will discuss the main results of this investigation, highlighting its implications at the local as well as at the European scale.

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A neighborhood-scale approach to the study of the impacts of invasive species on forest ecosystems

Lorena Gómez-Aparicio (1) & Charles D. Canham (2)
(1) Institute of Natural Resources and Agrobiology (IRNAS-CSIC), PO Box 1052, 41080, Sevilla, Spain;
(2) Cary Institute of Ecosystem Studies, PO Box AB, Millbrook, NY, 12545-0129, USA

Most studies analysing the impacts of invasive plant species on ecosystems use a plot-scale approach, in which plots dominated by the invasives are compared with adjacent plots dominated by natives. This approach can be useful to understand the net impacts of invasive species in advanced stages of the invasion process, once the invasives have taken over the system. However, during the early stages of invasion, when the distribution of the invasive species is patchy and intermingled with the native community, a more spatially-local approach is necessary to understand the capacity of exotic individuals to transform the system and therefore predict the consequences of invasion.

We propose the use of neighborhood-scale models as a promising tool to analyze the impacts of invasive species on ecosystems. Neighborhood models offer the possibility of linking species and ecosystems by expressing ecosystem processes as a function of the abundance, size and spatial distribution of dominant plants in the immediate neighborhood. Its application to the study of plant invasion allows answering basic questions regarding how invasive species create patches of influence, how these patches vary in size and intensity for different ecosystem and demographic processes, the extent to what they differ from those generated by native species, or the relationship between invasive abundance and its impacts on ecosystems. Moreover, when applied to different sites, these models allow characterizing how neighborhood-scale patterns vary at a regional scale.

We use the results of a study conducted in temperate forests of eastern North America invaded by *Acer platanoides* and *Ailanthus altissima* to illustrate how neighborhood models can be applied to understand invasive impacts on ecosystem function and community dynamics. Specifically, we show that the process of invasion by these two exotic tree species is characterized by predictable, neighborhood-specific acceleration of nutrient cycling rates, localized increases in soil nutrient concentrations, and positive and negative effects on the seedling community. However, these neighborhood effects are site-dependent for some ecosystem properties, suggesting that a given density of exotics can have impacts of different magnitude depending on the site. A spatially-explicit approach at different scales (i.e. neighborhood and site scales) is therefore necessary to understand the magnitude and generality of the transformations that take place during the early phases of invasion by exotic species.

Why waterfleas are similar to plants: a new invasion perspective

Tina Heger(1), Jonathan M. Jeschke(2,3) & Sylvia Haider(1,4,5)
(1) Technische Universität München, Lehrstuhl für Landschaftsökologie, Department für Ökologie und Ökosystemmanagement, Am Hochanger 6, 85350 Freising, Germany
(2) Ludwig-Maximilians-Universität München, Department Biologie II, Großhaderner Str. 2, 82152 Planegg-Martinsried, Germany
(3) Cary Institute of Ecosystem Studies, P.O. Box AB, Millbrook, NY 12545, USA
(4) ETH Zurich, Plant Ecology Group, Institute of Integrative Biology, Universitätsstrasse 16, 8092 Zürich, Switzerland
(5) Universidad de La Laguna, Departamento de Ecología, Avda. Astrofísico Francisco Sánchez, Campus de Anchieta, 38071 La Laguna, Tenerife, Islas Canarias, Spain

The study of invasive species, and of invasion mechanisms in particular, is often done separately for different taxa. To gain more general insights into invasion mechanisms, we searched for taxon-independent patterns. We formulated species characteristics that favor invasion success and are independent of taxonomic groups. This new approach breaks existing thought patterns and reveals previously overlooked similarities across taxa.

We subdivided the invasion process into four steps: (1) introduction (transport and release), (2) growth and reproduction of the first individuals introduced to the exotic region, (3) population growth to a sustainable population size, and (4) further spread and colonization of new sites. Based on the different problems and obstacles an organism is confronted with during invasion, we enunciated taxon-independent species traits that can promote invasion success. Some of these characteristics are only beneficial at one step, whereas others are beneficial at multiple steps. This general approach allows for comparing invaders across taxa. Furthermore, looking for traits that apply to all kinds of organisms forced us to get away from species-specific details and to open our thinking to a more general perspective.

From this perspective, waterfleas (e.g. *Daphnia*) and plants show some surprising similarities, as they share traits that support their invasion success. Considering, for example, the third invasion step, both organism groups can enhance the probability to reach a sustainable population size by producing propagules that enable outliving unsuitable conditions and waiting for a more convenient time period: waterfleas and some other crustaceans are able to produce resting eggs, and plants reach the same advantage with their seed production. Also, the resting eggs and seeds are sometimes transported accidentally, which helps them to reach exotic regions (first invasion step) and to colonize new sites (fourth invasion step). We will show that similar insights can be gained for other groups of organisms as well.

Poster presentations

Successful invasion without sexual reproduction? - Eurasian willows in Patagonia, Argentina

Katharina Budde (1), Leo Gallo (2), Paula Marchelli (2,3), Eva Mosner (1), Sascha Liepelt (1), Birgit Ziegenhagen (1) & Ilona Leyer (1)
(1) Philipps-University of Marburg, Faculty of Biology, Conservation Biology Group, Karl-von-Frisch-Str. 8, 35043 Marburg Germany
(2) Instituto Nacional de Tecnología Agropecuaria (INTA), Forest Genetics Unit, Bariloche, Argentina
(3) Consejo Nacional de Investigaciones Científicas y Tecnicas (CONICET), Argentina

Eurasian willow species (Salicaceae) were introduced to South America by European settlers. Since then their distribution has increased significantly along the rivers in northern Patagonia. In the area around lake Nahuel Huapi, only female shrubs and trees of the *Salix alba – S. fragilis* complex are known, suggesting dispersion exclusively by vegetative propagation.

We examined spatial distribution patterns of introduced willows of the *S. alb*a- *S. fragilis* complex along seven rivers near lake Nahuel Huapi. To distinguish between different genotypes, six microsatellite loci were used. The taxonomical status was determined by utilising the diagnostic gene marker C4H2.

We found dense willow stands along most of the rivers, consisting of willow trees belonging to a single genotype with a range of at least 621 km. Although we could prove the presence of other genotypes in the area, these were not spread along the studied rivers, but grew at single locations. Additional sampling along other rivers resulted in the detection of more genotypes. With the exception of one single *S. alba* individual, all other clones were hybrid willows, *S. x rubens* .

Distribution patterns of different clones are interpreted against the ecological and historical backgrounds. The invasiveness of a single individual, as well as the invasibility of the Patagonian ecosystems and the impact of invasion are discussed.

The role of inbreeding and long-distance gene flow on the invasive ability of *Senecio pterophorus*

Lidia Caño (1), Josep Escarré (2) & F. Xavier Sans (3)
(1) University of the Basque Country; Apdo 644. 48080 Bilbao, Spain
(2) Centre d'Ecologie Fonctionnelle et Evolutive (CNRS; 1919 Route de Mende, Montpellier, France
(3) University of Barcelona; Diagonal 64508028 Barcelona, Spain

Alien invasive species undergo genetic bottlenecks in the colonization of the new range which can lead to high levels of inbreeding within populations and subsequent reproductive constraints. Inbreeding depression causes a reduction in fitness by mating between related individuals. Deleterious alleles are thought to be the major source of inbreeding depression and they determine the genetic load of a population. Gene exchange between populations is often favourable because it masks deleterious recessive alleles and reintroduces advantageous alleles. Thus, in small founder populations, individuals issued from between-population crossing could have higher fitness than those issued from within-population crossing, an effect called heterosis.

This study deals with the effect of inbreeding and inter-population gene flow on the invasive ability of *Senecio pterophorus* DC (Asteraceae). *S. pterophorus* is a South African species that was recently introduced into NE Spain. We grew plants from seeds collected from several maternal origins in the native and in the introduced range. Plants were self-fertilised and outcrossed within families, within populations and between populations located in the other range.

Self-fertilised individuals from both origins produced almost no seeds, thus revealing self-incompatibility. Although a partial breakdown of the incompatibility system may be beneficial, to our knowledge, complete breakdown of the homomorphic self-incompatibility system following colonisation events has not yet been reported.

Only in plants from Spanish maternal origin inbreeding depression did reduce the seed set of the mother plants and the germination rate of the offspring. Our results may be indicative of a higher genetic load affecting early traits in the Spanish population than in the South African population. These results fit the prediction that genetic load increases following a bottleneck [1] and suggests that the genetic load affecting early traits are probably preventing higher rates of invasion than have been observed to date in NE Spain.

Inter-population crosses (involving populations from different ranges) produced higher fitness among the progeny of Spanish maternal origin than intra-population crosses. This reveals heterosis and suggests that repeated introductions may further promote the invasiveness of *S. pterophorus*.

We conclude that (i) increased genetic load in the introduced populations with respect the original populations may limit the spread of introduced plant species and that (ii) the invasiveness of alien plants may increase as a result of the inter-population gene flow caused by multiple introductions. We suggest that, in the context of biological invasions, more empirical studies are needed to test these theoretical predictions [1, 2] and their consequences on the spread of invasive species.

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Allelopathic effects of two invasive *Acacia* species on seed germination and seedling growth

João Crisóstomo (1), Dörte Bachmann (2) & Susana Rodríguez-Echeverría (1)
(1) Centre for Functional Ecology, Department of Botany, University of Coimbra, Calçada Martim de Freitas 3000 Coimbra, Portugal
(2) Department of Geobotany, Martin-Luther-Universität Halle-Wittenberg, Am Kirchtor 1, 06108 Halle, Germany

Allelopathy is defined as the process by which a plant inhibits the growth of another plant through the release of chemical compounds in the same or neighboring habitat (Muller 1969). It has been suggested that it plays an important role in the success of plant invasions, mainly because plant invaders often establish monocultures and also because native plants from the invaded community might be more susceptible to allelochemicals (Hierro 2003). *Acacia longifolia* and *A. saligna* are invasive plant species in Portugal, being the first more widely distributed in the central and northern sand dunes systems, while the second is invading mainly the southern coastal dunes (Marchante & Marchante 2005). The aim of this work was to test the possible allelopathic effects of extracts from leaves, flowers and litter, of both *Acacia* species, on seed germination and seedling growth. A bioassay was carried out with *Lactuca sativa*, which is a model species often used in allelopathic tests.

Leaves, flowers and litter from both species were collected and soaked in water to obtain the water-soluble extracts. Two ten-fold dilutions were made afterwards from the original extracts. Seeds of *Lactuca sativa* were placed in Petri dishes with the following extracts: leaves; flowers; litter; mixed (leaves extract with flowers extract) and with water controls. Germination percentage was recorded for five days and the lengths of the root and shoot were measured after eight days. A significant reduction of the final seed germination percentage was found for the most concentrated treatment of *A. saligna* flowers and the least concentrated mixed treatment of *A. longifolia*. A more pronounced effect of plant extracts was observed on seedling growth. The most concentrated flowers extracts of both *A. longifolia* and *A. saligna* caused a big significant reduction of root length. A significant, although smaller, increase in shoot length was observed for the same treatments.

These results indicate that *Acacia* flowers are the main source of putative phytotoxic compounds. Therefore, native species that germinate during the *Acacia* blossom period could be negatively affected by the released flower compounds (Carballeira 1999). The results also point out that the most pronounced effect of *Acacia* extracts is on seedling growth rather than on seed germination. The inhibition of root growth might therefore be one of the main processes by which these invasive species displace native vegetation and form monocultures. Further investigations should be carried out to test the allelopathic effects on the native plant species that are displaced by *A. longifolia* and *A. saligna* invasion.

Do native congeners increase post-dispersal seed predation in exotic species?

Petr Dostál
Institute of Botany ASCR, Zámek 1, CZ-252 43 Pruhonice; e-mail: dostal@ibot.cas.cz

It is hypothesized that the success of exotic species may be due to the loss of natural enemies during colonization of a new range (Enemy Release Hypothesis). On the other hand it is documented that diverse groups of pathogens or predators may switch to newly-arrived species, thus reducing the advantage of lost enemies.

In this contribution I demonstrate the differences in post-dispersal seed predation rate between 6 exotic plant species and their native congeners. Seeds of each species were left unprotected during the period of six months (after release from mother plant till germination period) or treated by fungicide or wire net protection. If the Enemy Release Hypothesis holds true, it would be expected that the difference in predation rate of protected and control seeds would be larger in native species.

In addition, I compared predation rate of protected and control seeds of exotics at sites with native congener population with predation rate at sites where native species was missing. It was expected that more seeds will be lost at sites with co-occurring congeners as they may host specialist enemies switching to seeds of exotic species.

Results of both experiments are discussed in the context of the formulated hypotheses.

Is the concept of invasive species acceptable in general invasion theory?

P. Elias
Dept. of Ecology, Slovak Agricultural University in Nitra

In last decades biotic invasions have been studied worldwide by many scientists and new data on specific invasions were obtained. But generalizations on invasion patterns and processes are complicated by spatial and temporal scales, as well as by other biological and ecological problems. The results of studies and analyses of biotic invasions in Central Europe (Slovakia) shown that the concept of invasive (alien) species is not acceptable in general theory of biotic invasions. The case study is presented to support above conclusion. Impatiens parviflora DC. introduction to Europe and its spread in new region was recorded and analysed by a (phyto)geographical approach and the species was classified as a neophyte or an agriophyte. Biological traits were studied to explain spread of the species in new regions. Long-term studies of invasion of deciduos oak-hornbeam forest (former I.B.P. Forest Research Site at Bab, SW Slovakia, since 1980) by the annual - as example concerning community invasibility and mechanisms of invasion - shown extremely large plasticity of the vascular plant and important role of community disturbance. It was evident that the concept of invasive behaviour of an alien species is more relevant to general theory of invasion that the concept of invasive species.

Flowering phenology pattern of invasive species in Mediterranean-type ecosystems

Oscar Godoy (1), Fernando Valladares (1), Pilar Castro-Díez (2), David M Richardson (3) & Margarita Costa-Tenorio (4)
(1) Instituto de Recursos Naturales. CCMA. CSIC. Serrano 115. E-28006 Madrid;(2) Univ Alcala de Henares, Fac Ciencias, Dept Ecol, Ctra Madrid Barcelona, Km 33-6, E-28871 Alcala De Henares;(3) Univ Stellenbosch, Dept Bot & Zool, Ctr Invas Biol, Private Bag X1, ZA-7602 Matieland, South Africa;(3) Univ Complutense Madrid, Dept Biol Vegetal, Ciudad Univ, E-28040 Madrid

Widespread introductions of plant species to areas outside their natural ranges, give us the opportunity to gain new insights on the importance of flowering phenology as a components of success of alien species in a new region, since elevated fecundity appears an important trait for invasiveness.

For this purpose, flowering phenology pattern of invasive plant species and native species were evaluated in three different regions with mediterranean-climate ecosystem (California, Spain and Cape Region). These three regions are disposed along a gradient of summer drought severity and they differ in their history of species introduction. In addition, to determine if invaders shift their flowering phenology when they are introduced in new regions, flowering invaders data were recorded from their climate origin regions using different Flora's atlas sources.

Invasive species conserve their flowering phenology when they are introduced in new regions or between different invaded regions. Invasive-native comparison reveals that temperate climate invaders flower before than natives (early spring), mediterranean climate invaders at the same time (mid spring-early summer) whereas tropical climate invaders flower later (mid summer-early autumn).

A displacement of invasive plant species related to native occurs, depending of the different climate origin proportion of invaders. In this sense, most of invaders in California have a mediterranean origin. Therefore, no flowering phenology displacement occurs between groups. However, in Spain and Cape Region most of the invaders have a temperate and tropical origin, thus a flowering phenology displacement exist, filling the invaders an empty temporal niche.

A high proportion of invasive species and specially those with summer phenology tolerate drought stress because they are invading microenvironments with continuous water supply such as disturbed areas. However, if the water stress is low as occur in the Cape Region the proportion of alien invading natural areas increase.

This study reveals that invasive species has a conservative flowering phenology strategy when they are introduced in new regions. Thus, different phenology pattern between invasive and native plant species is mainly a consequence of human-mediated actions and not a trait that confer invasiveness to alien species. History of alien introduction had joined together species with big differences in their evolution history. Their biotic consequences will vary among regions with similar climate. Competition for pollinators may be different depending if exist or not a displacement of the flowering phenology between invasive and native plants.

Biological invasions, regional identity and biodiversity. The example of *Rosa rugosa*

Maike Isermann (1), Anna Jürgens (2), Martin Diekmann (1) & Ingo Kowarik (2)
(1) University of Bremen, Vegetation Ecology and Conservation Biology, Leobener Strasse, 28359 Bremen, Germany
(2) TU Berlin, Ecosystem Science and Plant Ecology, Rothenburgstrasse 12, 12165 Berlin, Germany
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Biological invasions represent a major threat for biodiversity. The expansion of non-native plants often resulted in a decline of biodiversity, which concerns diversity of genes, species, communities, ecosystems, as well as of landscape. Especially in coastal dune areas of NW Europe, the expansion of *Rosa rugosa* is problematical, because of strong decline in species diversity. On the other hand, there are some positive aspects of *Rosa rugosa* such as erosion control, tourism control, and human's recreation-regeneration value. Using *Rosa rugosa* the project will exemplify, how a differentiate analysis of species invasion potential in relation to various habitats, could be used for nature conservation strategies. The project is dealing with following questions:

- Which genotypes and *Rugosa*-hybrids were and are planted in German coastal areas?
- What differences of invasion potential exist, regarding dispersal, establishment, and spreading between *Rosa rugosa* types in various coastal dune areas?
- How do different dune types vary in relation to habitat suitability in relation to *Rosa rugosa*?

Expected are results about the risk potential of different *Rosa rugosa* types, management recommendations on priority dune habitats as well as *Rosa rugosa* types main-focussed in relation to shrub removal, and probably recommendations on low-risk *Rugosa*-hybrids to be used in future for plantings in coastal areas.

Invasion success of mammals, birds, and other animals: The tens rule and the resistance hypothesis

Jonathan M. Jeschke
Ludwig-Maximilians-Universität München, Department Biologie II, Großhaderner Str. 2, 82152 Planegg-Martinsried, Germany
Cary Institute of Ecosystem Studies, P.O. Box AB, Millbrook, NY 12545, USA

An important question in invasion biology is: How many species will become invasive in a certain region? I am addressing this question from two different viewpoints.

First, the tens rule says that about 10% of the species introduced to an exotic region will become established there in the wild (establishment success) and about 10% of the established species will become invasive (i.e. they will substantially spread from their point of introduction; spread success). Hence, out of 100 species introduced, 10 will become established and 1 will become invasive. I present evidence that animals do not follow this rule. They have a much higher invasion success than predicted by the tens rule: their establishment and spread success was observed to be about 50%, i.e. out of 100 species introduced, 50 will become established and 25 will become invasive. However, the variation in establishment and spread success among different taxa is high. For example, mammals showed an establishment success of about 80% (n = 65 regions to which they were introduced) and a spread success of about 60% (n = 4), whereas birds showed an establishment success of about 50% (n = 53) and a spread success of about 35% (n = 3). Thus, while data from animals are generally not in line with the tens rule, some taxa are further away from this rule's predictions than others. In case of mammals – where out of 100 species introduced, about 80 will become established and about 50 will become invasive – the difference to the tens rule is 50-fold.

Second, the resistance hypothesis predicts that more species will become invasive in regions that are low in biodiversity and highly disturbed by humans. A variant of this hypothesis is that more species will become invasive on islands than on continents, as the biodiversity on islands is typically lower than on continents. Data from mammals and birds do not support this hypothesis, as no relationship was observed between establishment success of introduced species and the area (in km²) of the landmass where the species were introduced.

Invasion biology is still in its infancy. Many of its fundamental concepts and hypotheses lack a firm basis of evidence, and it is time to consider revising or replacing them.

Invasive potential of *Ageratum conyzoides* with special reference to its biology and ecology

Shalinder Kaur, & Ravinder K. Kohli
Department of Botany, Panjab University, Chandigarh – 160014, India

Ageratum conyzoides L. (billy goat weed; Asteraceae) is an annual weed native to South America, which has now naturalized several regions of Southeast Asia including India, China, and Korea. It is a vigorous colonizer of cultivated land, rangelands and pastures but can also be seen in bare areas, roadsides, along water channels and railway tracks. A number of biological and ecological strategies favor its invasive potential. Its growth and spread is very fast and over succeeds other vegetation due to its high reproductive potential. It is a prolific producer of seeds, which are small in size and lighter in weight and are easily disseminated by wind and water. In addition, the weed is also known to possess high regenerative potential and produces stolons, which add to its quick invasion. It has wide ecological amplitude and thus can grow on a variety of habitats and under different environmental conditions. Because of the quick spread of the weed, the farmers have to face huge economical losses in the agricultural lands whereas in the rangelands and pastures it leads to fodder scarcity and thus adverse effects on natural biodiversity. A study was conducted in the foothills / lower Himalayas, India to assess the distribution of weed in grassland, along water channel and a wasteland. It was observed that weed possess high density, frequency and dominance in the area of its infestation compared to non-invaded areas. Further, the indices of richness, evenness and diversity were found to be more in the weed invaded areas. On the other hand, the index of dominance was lesser indicating the dominance of this weed in the area of its invasion. The present study discusses the distribution, density, and ecological and biological characteristics of the weed highlighting its invasive tendency.

Experimental plant introduction: disentangling the roles of propagule pressure, soil disturbance and life-history traits

Anne Kempel, Thomas Chrobock, Markus Fischer & Mark van Kleunen
Institute of Plant Sciences, University of Bern, Altenbergrain 21
3013 Bern, Switzerland

An important issue in ecology is which factors determine successful population establishment of plant species. Identification of these factors is particularly relevant for biological invasions. It has been hypothesized that the ideal invasive plant should possess life-history characteristics such as fast and profuse germination, rapid growth, self-compatibility, adaptive phenotypic plasticity and high competitive ability. Empirical evidence for the role of species traits in invasiveness, however, is scarce. Moreover, the importance of species traits may depend on environmental factors such as soil disturbance, and might be overwhelmed by the introduction history of the species including time since introduction and propagule pressure.

The importance of intrinsic species characteristics and extrinsic factors on naturalization can be disentangled in experiments that use controlled introduction of species. Because these experiments have the risk of introducing new invasive species, such experiments have never been done. However, the risks can be reduced by using horticultural and native species that are already available in the target region instead of introducing new species.

To quantify and disentangle the roles of species traits, soil disturbance and propagule pressure, we have experimentally introduced 50 horticultural and 50 native herbaceous species at different propagule pressures in 16 grassland sites with and without soil tilling. Of these species, we will determine the establishment success over the next three years and assess how this relates to propagule pressure and soil disturbance. To determine the roles of species traits in establishment success, we will in other experiments assess seed and germination characteristics, growth rates, breeding systems, competitive abilities and plastic response to shading for the 100 study species. These characteristics will be related to establishment success in the field experiment. This project will be the first one to experimentally quantify and disentangle the influence of life-history traits, soil disturbance and propagule pressure on establishment success while controlling for time since introduction.

Invasibility of grassland and heath communities exposed to extreme weather events - additive effects of diversity resistance and fluctuating physical environment

Juergen Kreyling (1,2,3), Carl Beierkuhnlein (3) & Anke Jentsch (1,2)
(1) Conservation Biology, UFZ - Helmholtz Centre for Environmental Research Leipzig-Halle, Permoserstr. 15, D-04318 Leipzig, Germany
(2) Disturbance Ecology and Vegetation Dynamics, University of Bayreuth, D-95440 Bayreuth, Germany
(3) Biogeography, University of Bayreuth, D-95440 Bayreuth, Germany

Understanding the resistance of plant communities to invasion is urgent in times of changes in the physical environment due to climate change and changes in the resident communities due to biodiversity loss. Here, we test the interaction between repeated drought or heavy rainfall events and functional diversity of grassland and heath communities on invasibility, measured as the number of plant individuals invading from the matrix vegetation.

Invasibility of experimental plant communities was influenced by extreme weather events, although no change in above-ground productivity of the resident communities was observed. Drought decreased invasibility while heavy rainfall increased invasibility, a pattern that is consistent with the fluctuating resource hypothesis. Higher community diversity generally decreased invasibility, which can be explained by a combination of the fluctuating resource hypothesis and niche theory. The effects of the physical environment (extreme weather events) and biotic resistance (community composition) were additive, as they were independent from each other.

Differences in the composition of invading species sets were found, and Indicator Species Analysis revealed several invading species with significant affinity to one particular extreme weather event or community composition. This finding supports niche theory and contradicts neutral species assembly.

Our data supports theories which predict decreased resistance of plant communities due to both increased climate variability and biodiversity loss. The effects of these two factors, however, appear to be independent from each other.

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Plant-soil feedbacks in *Carpobrotus edulis*: mechanisms of invasion and consequences for the native plant community

Eduardo de la Peña (1,2), Susana Rodríguez-Echeverría (2), Sergio Roiloa (2) & Dries Bonte (1,3)*
(1) Terrestrial Ecology Unit (TEREC), Department of Biology, Faculty of Sciences, Ghent University, K.L. Ledeganckstraat 35, 9000 Gent Belgium
(2) Centre for Functional Ecology, Universidade de Coimbra, Coimbra 3000 Portugal.(3) Field station Fabrikschleichach, Wurzburg University, Rauhenebrach, Germany

The genus *Carpobrotus* is a taxa of succulent clonal plants native to South Africa and introduced in different areas of the Mediterranean for gardening and soil stabilization purposes. *Carpobrotus edulis* and *C. acinaciformis* are nowadays considered highly invasive species in coastal areas of Southern Europe because they form dense fast-growing mats that displace the native dune vegetation. Previous studies on the invasive biology of this species have mainly focused on the sexual reproduction of *Carpobrotus* spp. or the direct impact on the structure and dynamics of the native vegetation and native plant-pollinator networks. Other factors involved in the mechanisms of invasion such as the effect of soil biota on plant growth and reproduction have not been previously addressed. Native dune species are usually associated with a wide diversity of soil organisms, from mutualistic arbuscular mycorrhizal fungi and rhizobia to root-feeding nematodes, which play a key role in plant succession in coastal dunes. Plants can also change the composition of the soil communities and some invasive plants do so in order to create positive plant-soil feedbacks that enhance the growth of their congeners and hamper the growth of native species. Nevertheless, and in spite of the large dense patches formed by *Carpobrotus* spp., no information is available about its effect on soil biota or the existence of plant-soil feedbacks.

In this study we evaluated the effect of different soils collected from an invaded coastal dune system in central Portugal on *C. edulis* performance. Dense mats of *C. edulis* usually present a combination of areas of dead branches together with areas of vigorous growth. Therefore, we selected rhizosphere soils from both areas in large monospecific patches in order to check if this dying-back effect could be related to soil biota. In addition, bare dune soil that has not been occupied by *Carpobrotus* spp. (naïve soil) was also collected and used for the experimental set-up. Different plant-growth related parameters such as vegetative growth, biomass allocation, floral traits and seed production and germination were measured during the course of the experiment in the three soil treatments compared. Our initial hypothesis is that *Carpobrotus* spp. can modify the soil biota, and nutrient content, to its own benefit. Therefore, we expected that *C. edulis* would grow better in the soils where vigorous growth was observed in the field. The obtained results, however, show that differences in soil composition can change the rate of vegetative/sexual growth of this clonal species. Interestingly, flower production in the naïve soil was significantly higher than in the soil already occupied by *Carpobrotus*. Our results indicate that *C. edulis* modifies the soil conditions to maximize the advantages of clonal growth, and can quickly switch to invest more on sexual reproduction when soil conditions are not optimal for vegetative growth. The effect of soil biota on seed germination of *C. edulis* and native plant species is currently under study.

Dendroecological investigations to growth and spread of Black Crawberry (*Empetrum nigrum* L. s. str.) on the Isle of Spiekeroog (East Frisia/Northern Germany)

Sebastian Schlering & Andreas Vogel
Westfälische Wilhelms-Universität Münster, Institut für Landschaftsökologie; Robert-Koch-Str. 26-28, 48149 Münster, Deutschland; sebastianschlering@uni-muenster.de

Nowadays, northern slopes of old dunes fields of Spiekeroog are characterised by thick and monotonous stands of the dwarf shrub *Empetrum nigrum*. During the last decades, this ligneous chamaephyte has strongly spread on the island. Within 45 years (1959-2004) the *Empetrum* covered area quintupled (see Table 1).

Table 1: Area of Hieracio-Empetretum stands on Spiekeroog, a comparison of 1959 and 2004 (source: WIEMANN & DOMKE 1959; NATIONALPARKVERWALTUNG WILHELMSHAVEN 2004).

year	area (m^2)
1959	111.627
2004	576.138

For the record of the potential length growth, we collected 15 vital shoots at optimal sites (humid northern slopes) to measure the accretion for each of the last 5 years. The average growth rate was found to be 17 cm/year. The highest value was 30 cm/year and the lowest 3 cm/year.

The assessment of the age distribution and the maximal age of individuals were done by collecting 130 basal shoots from all of area of old dunes on Spiekeroog. By means of a sledge microtome we produced 12-15 µm thin cross sections, which could be measured after colouring and fixation. For the analysis of year ring numbers and width, the use of a microscope was essential, because *Empetrum* often produces so called false year rings. These can be the result of short but extreme climatic fluctuations during the growing season (SCHWEINGRUBER 2001). The use of a binocular resulted into many aberrations of correct age determinations.

The oldest individual measured 75 years and was to be found in the area of the old tertiary dunes of SE Spiekeroog as expected. Most individuals counted between 10 and 40 years. Field observations showed that the oldest *Empetrum* individuals exist on dune crests and not on the favourable northern slopes. Furthermore, we observed a reclining of old shoots with length up to 150 cm against supports such as small trees and fences, which can be defined as a benefit in their struggle for light.

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Is *Cotoneaster franchetii* invasion in Central Argentina facilitated by Eurasian livestock?

E. Villadé (1), P. Tecco (2), D. Renison (1), I. Lett (1) & I. Hensen (3)
(1) National University of Córdoba, Department of Ecology, Av. Velez Sarsfield 299, 5000 Córdoba
(2) Instituto Multidisciplinario de Biología Vegetal, CONICET-UNC, Argentina
(3) Martin-Luther-University Halle-Wittenberg, Department of Geobotany and Botanical Garden, Am Kirchtor1, 06108 Halle, Germany

Grazing in areas with long evolutionary histories of large herbivores is supposed to reduce biotic invasion, while grazing exclusion is supposed to promote invasion, particularly in nutrient rich habitats [1]. However, grazing induced invasion resistance may be reduced when invasive species complexes are introduced, for example, large herbivores and the plants with which they most likely have co-evolved. A case in point is the Asian woody shrub *Cotoneaster franchetti* in its invasion into the mountains of central Argentina which have been grazed by Eurasian livestock for over 400 years while native large herbivores have become completely extinct. We studied *C. franchetti* regeneration along a fence-line separating an area of 200 ha with and without livestock. We sampled 30 *C. franchetti* seeder trees and their surroundings on each side of the fence-line and recorded any signs of browsing, number of seedlings shorter or larger than 5 cm as well as the microsite characteristics surrounding sites with or without seedlings. We recorded 892 seedlings, of which only 8% showed any signs of browsing. Small seedlings were found at similar densities with and without livestock influence. In contrast, large seedling density was significantly higher in the area with livestock, irrespective of shrub canopy cover. Seedling density under and out of the canopy of the seeder shrubs were 7 and 0.3 seedlings/m^2, respectively. Seeder shrub size exerted a positive effect on seedling density. Microsite characteristics were important out of the shrub canopy only on sites where seedlings were usually more shaded and more south oriented than on sites without seedlings, irrespective of livestock presence. We conclude that livestock produce both some negative effects on *C. franchetti* through browsing and positive effects on large seedling recruitment possibly through a reduction of competition with native species which are heavily browsed and grazed. It is also possible that *C. franchetti* avoids browsing by producing secondary chemical compounds. Large seedlings of a similar native shrub/tree (*Polylepis australis*) which dominated the area prior to livestock introduction are highly browsed which strongly reduces adult recruitment [2]. As such, the presence of Eurasian livestock favours the recruitment of the Asian shrub and hinders the native shrub/tree. Our study therefore suggests that the Eurasian plant/herbivore complex is more successful in its invasive potential than the plant alone. Given the high *C. franchetti* seedling densities both in areas with and without livestock, livestock management does not seem to be suitably effective in controlling *C. franchetti* invasion in Central Argentina and should be modified accordingly, especially for shady south facing areas.

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Biological invasion and dispersal mechanisms

3.5. The ecology and evolution of dispersal in changing landscapes

Hans Joachim Poethke, James Bullock

Oral presentations

Ecological and evolutionary consequences of seed dispersal disruptions in the Balearic Islands (Western Mediterranean Sea)

Anna Traveset
Spanish Research Council, Miquel Marqués 21, 07190 Esporles, Mallorca, Balearic Islands, Spain

By altering ecological interactions that have arisen over evolutionary timescales, invasive alien species have the capacity to influence the composition and functioning of invaded ecosystems. Specifically, disruptions to seed-dispersal mutualistic interactions are often documented, although the profound implications of such impacts are not widely recognized. In this talk, I am going to present different examples of such disruptions taking place in insular ecosystems, specifically in the Balearic Islands and in the Canary Islands, showing some of their ecological and evolutionary consequences. The implications for global biodiversity are still difficult to predict, as most evidence is from studies performed at the population level. Further insights are needed on the degree of resilience in interaction networks, but the available information suggests a major challenge for conservation biologists.

Influence of life history attributes on the formation of biodiversity patterns in neutral landscapes

Eva Stehle, Hans-Joachim Poethke & Thomas Hovestadt
Würzburg University, Field Station Fabrikschleichach, Glashuettenstrasse 5, D 96181 Rauhenebrach, Germany

Much of diversity theory is concerned with the formation of diversity patterns in equilibrium conditions. Real communities and landscapes are mostly, however, in the status of transition, due to e.g. changes in landscape utilization or climatic change.

One possible situation of such a transition is the abandonment of monocultures as it occurs in agriculture as well as in forest management. We implemented an individual- and grid-based, spatially explicit model based on the assumptions of Hubbell's neutral theory (ecological drift model, [1]) to examine the emergence and transition of biodiversity patterns for species belonging to the same functional group and sharing (approximately) similar life-history attributes. By modifying the model parameters, we can expand the model to compare the development of diversity patterns in transition across non-interacting species groups with different life-history attributes. We specifically focus on three parameters, fertility, dispersal ability, and longevity. We use this modelling framework to explore a number of critical questions:

- How do different life-history attributes influence the transition into equilibrium in the aftermath of land-use change?
- How is this affected by the size and shape of the area undergoing a change in use?
- How does diversity correlate between non-interacting functional groups characterized by different life-history parameters?

We find that species groups with different life-history attributes develop quite different spatial as well as temporal patterns of diversity, and that these patterns are differentially affected by the spatial attributes of disturbances, like (abandoned) monocultures. It is thus far from obvious how diversity will correlate across different functional groups if the history of actual study sites is not known.

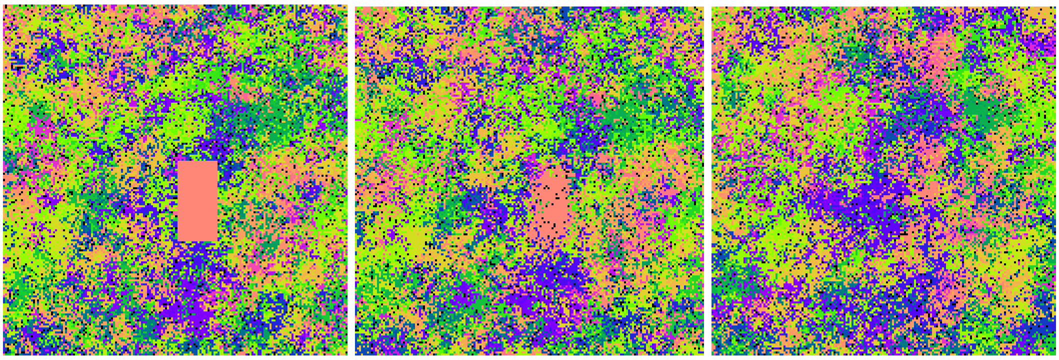

Figure1: Influence of an abandoned monoculture on diversity patterns (species=colors), left panel t_0, i.e. moment of abandonment, middle panel t=20, right panel t=200.

[1] Hubbell S.P. 2001. The unified neutral theory of biodiversity and biogeography. Princeton University Press, Princeton, New Jersey, USA.

Tree recruitment after fire events: Implications for species composition and biomass dynamics in Siberia

Susanne Tautenhahn (1), Christian Wirth (1), Anja Fankhänel (1) & Hermann Heilmeier (2)
(1) Max Planck Institute for Biogeochemistry – Jena, SNWG Organismic Biogeochemistry
(2) TU Bergakademie Freiberg, Interdisciplinary Ecological Center.

1.5% of the Siberian forest area burns each year. With the pronounced climate warming in northern latitudes these fires are predicted to become larger and more frequent. The annual area burned as detected by remote sensing imagery has increased during the last 20 years both in Eurasia and North America.

The larger the fire size the further the seeds have to disperse to reach the center of the burned area. Species with far dispersed seeds (deciduous broadleaved pioneers) thus have an advantage in colonizing large burned areas, which may trigger a shift from coniferous evergreen to deciduous broadleaved forest at the landscape level.

This change in species composition has been identified as important negative feedbacks to climate change involving changes in albedo and carbon uptake.

To address the impact of fire intensity and burned area size on the carbon budget and the species composition, we developed a model inversion procedure that estimates recruitment densities as well as biomass accumulation per unit area based on the patterns of surviving trees. The model accounts for recruitment density as a function of distance and density dependent competition. We parameterized the model using data on sapling densities from a 20 years old *Pinus sylvestris* burn (Figure 1) and data on size - biomass allometry from more than 40 sample trees.

We use the model to predict the biomass of virtual burned landscapes of varying sizes with different densities and spatial patterns of surviving trees to address the question, which combination of these factors maximizes the biomass recovery and fire resistance of the regeneration after fire events. The model has been designed to be incorporated in a forward mode into a landscape model of forest succession and carbon dynamics.

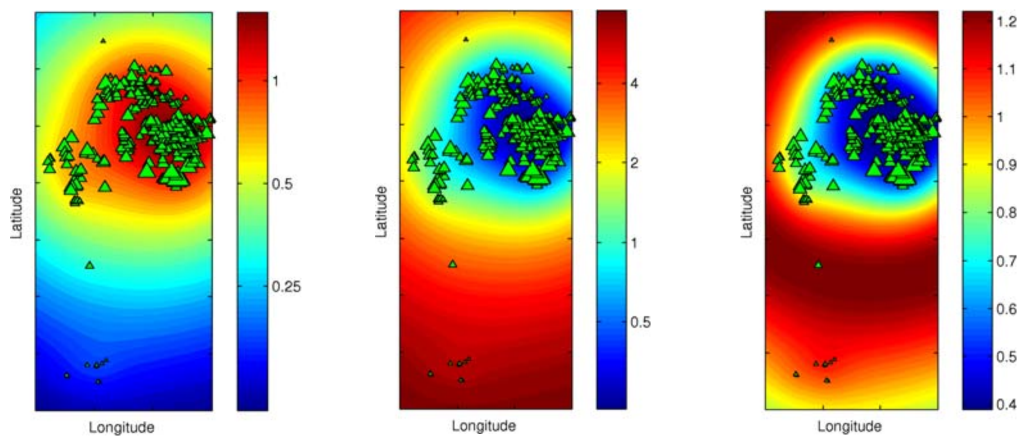

Figure 1: Model parameterization for the 20 year old *Pinus Sylvestris* burn in Central Siberia: (A) Landscape of sapling density of *Pinus sylvestris* [1/m²], (B) Mean saplings biomass as modified by density-dependent competition [kg DW], (C) Landscape of Biomass [kg DW/ m²], Seed trees (triangles) were measured in the field.

Water dispersal as an additional pathway to invasions by *Ailanthus altissima*

Ina Säumel & Ingo Kowarik
TU Berlin, Section Ecosystem Science / Plant Ecology, Rothenburgstr.12, 12165 Berlin

Long-distance dispersal is a key process in biological invasions which are acknowledged as both outcome and driver of global change. Previous research has emphasized the role of nonstandard dispersal vectors, but consequences of a change in dispersal vector for the establishment of invasive plant species have received less attention. We analyzed how water-mediated dispersal rather than the more expected wind-mediated dispersal can affect the establishment of the invasive tree *Ailanthus altissima* in riparian corridors by changing the germination rate and velocity and by providing a new pathway of vegetative propagation.

We (1) released tagged *Ailanthus* fruits into the river Spree in Berlin to test water dispersal under realistic environmental conditions. By a green house experiment, we analyzed (2) how submergence or floatation of fruits affected the germination process, and (3) whether stem fragments were able to set roots after a travel in water.

Our results demonstrate the effectiveness of water-mediated dispersal in *Ailanthus* as “wind-dispersed” species: 27% of exposed samaras drifted for 1,200 m within less than 3 h although this river section was heavily used by boats. This suggests long-distance dispersal over great distances from urban tree plantations as dispersal foci. Length and type of fruit contact with water led to divergent germination responses. Generally, germination was enhanced in floating compared to submerged fruits. After floatation, the maximum number of emerged seedlings was achieved more than 3 weeks earlier than in all other treatments. Experiments with stem fragments revealed the option of a novel pathway for long-distance dispersal in river corridors: 33–75% of buried stem fragments that had floated between 0-10 days produced adventitious shoots, 10% also set roots.

The results suggest that both generative and vegetative propagules of *Ailanthus* can be dispersed at regional scales in river corridors. Our findings show the importance of control of initial colonizations in riparian habitats and emphasize the need to include consequences of secondary dispersal when modelling the spread of invasive species. Furthermore, we expect that the hydrochory dispersal potential described here in the case of *Ailanthus* will interact with the impacts of global climate change. As many growth traits of *Ailanthus* have been shown to respond positively to elevated temperatures, we expect increasing floodplain invasions towards the northern limits of its current range. In addition, a greater intensity of flooding events due to climate change may enhance both the abscission of propagules and the distances they are moved by water.

Efficient long-distance gene flow into isolated oak stands in Baschkortostan (Russia)

Jutta Buschbom (1), Yulai Yanbaev (2) & Bernd Degen (1)
(1) Institute for Forest Genetics, Johann Heinrich von Thünen-Institute, Federal Research Institute for Rural Areas, Forestry and Fisheries, Sieker Landstr. 2, 22927 Grosshansdorf, Germany
(2) Sibai University, Belova-21, 453837 Sibai, Russia

The survival of tree species as long-lived sessile organisms in constantly changing environments depends either on their ability to quickly adapt to changing local conditions, on mechanisms of efficient gene flow to maintain genetic diversity and spread (potentially) advantageous alleles and their dispersal to suitable habitats. So far, the relative roles of local adaptation versus long-distance gene flow are unknown. Here we show that long-distance pollen-mediated gene flow over more than 100 km in the wind-pollinated tree species *Quercus robur* is highly efficient and contributes significantly to pollination events in isolated and small relict oak stands at the limit of the species' distribution.

The two investigated oak stands near Sibai (Baschkortostan, Russia) are located in the forest-grassland transition zone east of the Southern Ural Mountains. Both stands are 30 km apart with the next closest known oak occurrences being 150 km to the West across the Ural Mountains. All adult trees (20 and 7 individuals) present in the two stands were genotyped at nine microsatellite loci. 61 offspring (acorns and natural regeneration) were collected in the fall of 2007 and genotyped for the same microsatellite markers. Parentage assignment was conducted using an exclusion- and a maximum likelihood-based approach.

For only 15-20% of all offspring could perfectly fitting parent pairs be reconstructed from adult trees within the two stands. Allowing for mismatches between parents and offspring the likelihood approach reconstructed parent pairs from within the stands for only 33-40% of all offspring at a confidence levels of 95%. Between the two stands no successful gene flow event is observed. However, a large number of alien alleles not present in the local stands are found in the offspring generation. The maximum likelihood approach incorporates potential sources of error, as for example mutations and mistyping of alleles. The data, thus, suggest that extensive and successful long-distance gene flow exists in this wind-pollinated dominant forest tree species.

Transhumance promotes dispersal in fragmented landscapes

Philipp Kollmar, Stefanie Schuder, Peter Poschlod & Christoph Reisch
University of Regensburg, Institute ofBotanyD-93040 Regensburg, Germany

In the European cultural landscape the effects of increasing isolation between populations of plants increase a manifold of problems. Connections between the populations are important on different levels like flow of pollen, seeds and genes. We studied the effects of transhumant shepherding (an ancient form of husbandry) in South-eastern France. Transhumant flocks travel two times a year between the winter pastures and the summer pastures in the Alps (Figure 1). The genetic composition of the common species *Medicago minima* L. was studied along a transhumance route and a reference route with the AFLP-technique. The results of testing 200 individuals of 20 populations were 182 scorable fragments. Population variability, measured as Nei's gene diversity, Shannon's Information Index and percentage of Polymorphic bands, was not significantly higher along the transhumance route. An Analysis of molecular variance indicated high levels of variance within the populations of both routes. In a scatter plot of all individuals they are thoroughly mixed and no separation between the two routes was indicated. Mantel test indicated a strong and significant correlation between pair wise genetic (Φ_{PT}) and geographic distances along the transhumance route (r= 0.515; prob.= 0.002) and no correlation along the reference route (r= 0.003; prob.= 0.474). This indicates that populations from the transhumance route are connected to each other by regular dispersal effects, whereas the other populations only exchange seeds through erratic processes. This result is reinforced by the analysis of the wool of a transhuming sheep. Each day the diaspores in the wool were collected and determined. This resulted in 1012 counted seeds for *M. minima* on the route to the summer pastures by a single sheep whereas a flock consists of approximately 1000 sheep.

Figure 1: A transhuming herd of sheep and goats. (Photo: Philipp Kollmar)

The results of the study highlight the role that large ruminants play for the dispersal of plants in the fragmented landscape we face today.

The herbivore-seed interaction: weak support for Janzen's idea

Bram D'hondt (1) & Maurice Hoffmann (1,2)
(1) University of Ghent, Terrestrial Ecology Research Unit; K.L. Ledeganckstraat 35, 9000 Ghent, Belgium
(2) Research Institute for Nature and Forest; Kliniekstraat 25, 1070 Brussels, Belgium.

Dispersal is a central theme within plant ecology. After all, seeds aim at ensuring population continuity through space and time. Examples abound of seed structures that have clearly evolved to promote dispersal by wind (cf. pappi) or on the inside of animals (cf. berries). Only recently, however, attention has turned to the seeds of all those species –the majority- with no obvious adaptations for dispersal [1]. In 1984, Janzen [2] postulated a remarkable idea: the small, dry-seeded syndrome typical of some herbaceous plants, might result from the benefits offered to them by herbivorous mammals consuming and thereby dispersing the seeds (endozoochory). Indeed, these animals are known to disperse vast seed numbers of a wide range of herbs and grasses. As in the preagricultural woody vegetation, these animals probably frequented the discontinuous and ephemeral habitats that were home to those species, selection favoured plant characteristics promoting herbivory and seed characteristics enhancing escape from digestion, i.e. small, dry, inconspicuous seeds. This idea is referred to as the 'foliage-is-the-fruit' hypothesis.

However, alternative hypotheses exist for the observation of seeds without clear dispersal characteristics (for review, see [3]). Seeds may, for instance, lack a dispersal mechanism just because of various trade-offs or because of selective forces other than (endozoochorous) dispersal. Here, Janzen's hypothesis has to withstand severe competition as some of the alternative hypotheses are clearly more parsimonious.

In this talk, I discuss the results of a feeding experiment designed to test for the seed trait correlations assumed by the hypothesis. We fed diaspores of more than 40 plant species to cattle in order to determine the proportion of seeds surviving digestion, a crucial stage within the endozoochorous cycle. Using -mainly- congeneric pairs of species, common ancestry could be controlled for. The results suggest that neither seed size, seed weight or shape adequately explains digestion survival. In addition, it is shown that significant correlations found in other studies are deflated when phylogeny is taken into account. Until today, we thus lack easy-to-measure seed traits accounting for endozoochorous success adequately. However, one particular seed trait, so-called "hardseededness", seems to have a good explanatory power. Although its taxonomic scope is limited (e.g. Fabaceae, Cistaceae), it might prove to be a suitable system for testing the adaptive significance of endozoochory.

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Dispersal and environmental change: spatial interaction models as a general framework

Olav Skarpaas
Norwegian Institute for Nature Research, Gaustadalléen 21, NO-0349 Oslo, Norway

Dispersal is a central concept in ecology. However, various research traditions within ecology define and quantify dispersal differently, often depending on specific movement adaptations and characteristics of particular organisms such as birds, insects, plants or diseases. To address the spatial responses of this wide range of organisms to environmental change there is a need for a more general definition and general quantitative descriptions (models) of dispersal. Many existing dispersal models focus on relocation, and ignore important processes at the source and the destination. I discuss spatial interaction models as a general conceptual and quantitative cross-taxonomic framework for dispersal. This framework captures three main movement processes in all organisms: source processes, relocation processes and destination processes. A special case of spatial interaction models is the gravity model, which has found several applications in biological invasions and epidemiology. Using examples from a range of organisms, I illustrate how different dispersal mechanisms can be incorporated in spatial interaction models, and how this can be used to assess dispersal responses to environmental change.

Animal movement and the spatial patterns of seed dispersal in endozoochorus systems

Luis Santamaria (1), Asier R. Larrinaga (1), Javier Rodríguez-Pérez (1), Ahimsa Campos-Arceiz (2), Miguel A. Rodríguez-Gironés (3) & Eloy Revilla (4)
(1) Mediterranean Institute for Advanced Studies, CSIC-UIB; Miquel Marquès 21, 07190 Esporles, Spain
(2) Laboratory of Biodiversity Science, The University of Tokyo, Tokyo, Japan
(3) Estación Experimental de Zonas Áridas, Almería, Spain
(4) Estación Biológiva de Doñana, Sevilla, Spain

The spatial distribution of seeds sets the template on which subsequent plant demographic processes take place. For plants dispersed by frugivores and herbivores, spatial patterns of recruitment are primarily influenced by the spatial arrangement and characteristics of adult plants, the feeding behaviour and movement patterns of the dispersers, and the structure of the habitat matrix. Traditional approaches to study dispersal have however ignored the spatial component. In contrast, a recent outburst of interest in the study of the factors determining dispersal distances and patterns of seed deposition is providing increasing evidence that animal movement patterns play a primary role in determining seed fate and the structure plant populations. In this paper, we present a framework for the study of the distance and spatial patterns of deposition in endozoochorously dispersed seeds. Such distances and patterns depend primarily on the interplay of three variables: the gut passage time of plant seeds and its effects on seed viability and germination the movement pattern of animal dispersers (speed and directionality) the home range of animal dispersers.

The relative importance of these three variables at each specific plant-disperser system defines a gradient of situations, which has a strong bearing on the approach to study and model its functioning. At one extreme of the gradient, dispersers show relatively short gut-passage times, slow movements and large home ranges. In such systems, dispersal distance is strongly influenced by the interplay between gut-passage time and movement speed, and dispersal patterns primarily depend on preferential movement directions over the habitat matrix. Whenever seed viability or germination decreases with gut-passage time, it will result in a trade-off between dispersal distance and dispersal quality. At the other extreme, dispersers show relatively long gut-passage times, fast movements and small home ranges. In such systems, dispersal distance and pattern will primarily depend on the dispersers´ home range size and their pattern of space use within it. Dispersal distance does not increase with retention time, but seeds kept long in the dispersers´ gut still show decreased recruitment whenever viability and germination decrease with gut-passage time.

These two cases should not be taken to represent discrete categories for the study of endozoochorous dispersal. Instead, they show the extremes of a range of possibilities in which the majority of cases will represent various mixtures of both cases. Even more, many dispersal systems will shift between both extremes over various time scales. Examples include those in which dispersers show sedentary and migratory phases (e.g. migratory waterfowl, savannah ungulates), stable adult ranges with juvenile dispersal, or strong seasonal changes in home range size and movement patterns.

A semi-mechanistic model for dispersal of seeds attaching to discrete agents

Matthias Wichmann (1), Stephen Galsworthy (2) & James Bullock (1)
(1) Centre forEcology & Hydrology CEH Wallingford, Maclean Building, Benson Lane, Crowmarsh Gifford, OX10 8BB, UK
(2) Centre for Mathematical Biology, University of Oxford, Mathematical Institute, 24-29 St Giles', Oxford OX1 3LB, UK

Understanding the dispersal of seeds is a fundamental issue in plant population ecology at all spatial scales. At the local scale dispersal influences population growth and persistence, at the regional scale dispersal allows the occupation of newly available habitat and at even larger scales dispersal leads to population spread and invasion. In particular when focussing on the two larger scales the study of long distance dispersal (LDD) has become increasingly important. Dispersal by wind is probably best understood with a few sufficiently large datasets and a variety of mechanistic models being available. Dispersal by other vectors, e.g. water or animals is less well studied and reliable models have not yet been developed.

The traditional and probably conservative exponential model for dispersal assumes that the rate of seeds detaching from the vector is constant. A similar assumption is made by studies that combine movement paths of discrete agents (e.g. animals) with average detachment rate (or retention time) in order to construct a dispersal kernel. However, for dispersal by discrete agents this assumption may not hold as the detachment rate may not be constant throughout the entire dispersal process. In particular, detachment rate may increase with distance as seeds loosen with continuous movement. Alternatively detachment rate may decrease with distance as seeds loosely attached to the vector fall off first but those that are more stuck stay on for longer distances.

We here present empirical data on the dispersal of seeds by human vectors. We use these data to explore the suitability of different varieties of models making the above assumptions to simulate and predict seed dispersal by discrete agents. We present the model that best fits our data but also test this model on other available datasets. We argue that our model is generally valid for dispersal of seeds by discrete agents.

Evidence for Lévy Flights in walking behaviour of aphids in a homogeneous environment

Alla Mashanova (1), Tom H. Oliver (2) & Vincent A.A. Jansen (1)
(1) School of Biological Sciences, Royal Holloway, University of London, Egham, Surrey TW20 0EX, UK
(2) Centre for Ecology and Hydrology, Crowmarsh Gifford, Wallingford, Oxfordshire, OX10 8BB, UK

A Lévy flight is a type of movement where the step lengths are drawn from a power law distribution. Power laws are 'fat-tailed' distributions which mean that numerous short steps alternate with long (and very long) steps. As a result simply by chance some individuals (or any individual at some point in time) can travel a very large distance. Lévy flights have been reported for a variety of species from *Drosophila* to albatrosses and humans. Theoretical studies showed that Lévy flights are beneficial when animals search for non-renewable sparsely and randomly distributed resources and, possibly, to avoid the patches depleted by other animals.

In our study we placed black bean aphids in Petri dishes with no clues about the food distribution and video-recorded their movement [1]. We found that even in a homogeneous environment aphids moved showing Lévy flights [Fig. 1]. In 'natural' conditions aphids feed on leaves which are connected to each other and so aphid food sources are neither sparsely nor randomly distributed. Therefore, our finding suggests that Lévy flight behaviour is not limited to a search for sparsely distributed resources but can be expected for a broader range of scenarios. Being 'super diffusive' Lévy flights are important when forecasting dispersal since animals might move much further than predicted by a more conventional random walk approach.

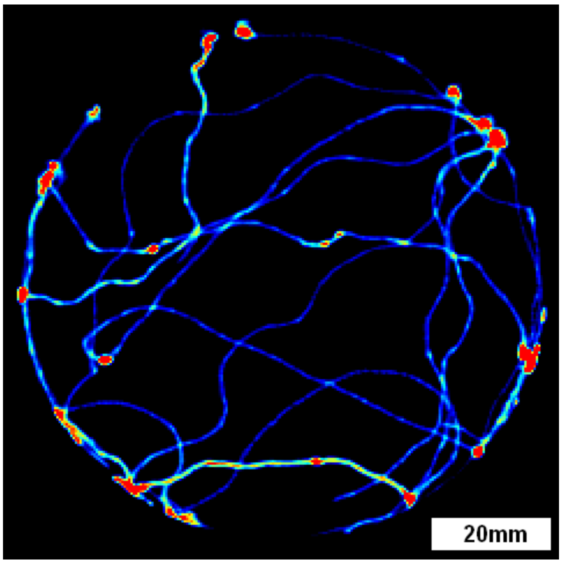

Figure 1: An image of aphid tracks in a Petri dish showing temporal variance of the pixel intensity during the record. Blue lines correspond to movement. The darker the line the faster an aphid moved. Green patches correspond to slowing down or short stops while red spots correspond to long stops. It can be seen that the paths are not homogeneous – fast movement is often interrupted by slowing down or a complete stop. Such intermittency is an indication of Lévy flights. This image was obtained using free GMimPro software (www.nimr.mrc.ac.uk/GMimPro).

[1] Oliver T.H., Mashanova A., Leather S.R., Cook J.M. and Jansen V.A.A. Ant semiochemicals limit apterous aphid dispersal. *Proc. R. Soc. B* 274:3127-3133

Epizoochorous seed dispersal by red fox in relation to seed availability

Knut Anders Hovstad (1), Silje Borvik (2) & Mikael Ohlson (2)
(1) Norwegian Institute for Agricultural and Environmental Research, Grassland and Landscape Division, Kvithamar, NO-7500 Stjørdal, Norway
(2) Norwegian University of Life Sciences, Department of Ecology and Natural Resource Management, P.O. Box 5003, NO-1432 Ås, Norway.

Epizoochorous seed dispersal on the red fox was examined by walking a fox dummy through a semi-natural grassland and comparing seeds found on the dummy to estimated seed availability in the vegetation. The potential for seed attachment in different species were compared using an index, I_{seed}, defined as the number of seeds on dummy after a fixed distance, divided by seed density (1000 seeds m^{-2}) in the vegetation. Seed attachment was related to plant and seed traits by fitting a zero-inflated negative binomial model. Only species with mature seeds, i.e. seeds that could be dispersed naturally, were included in the analysis and the results presented are means from ten independent runs (Table 1). An extended description of the experimental approach together with results on seed retention in fur is provided elsewhere [1].

Twenty-nine species with mature seeds were observed in the vegetation and 19 of these species (4500 seeds in total) were found on the fox. Most of the seeds that attached to the coat originated from a few species. The most common seeds on the dummy were from the grasses *Deschampsia cespitosa* (84.2 %) and *Agrostis capillaris* (6.2 %), whereas the most abundant herb seeds on the dummy were *Rumex acetosa* (2.9%) and *Ranunculus acris* (1.9 %). The number of seeds available in the vegetation differed greatly among species [1], and when adjusted for seed availability, *Geum rivale* and *Festuca ovina* had the highest potential for seed attachment as judged by the index I_{seed}. In some species, I_{seed} displayed large variations due to a patchy distribution. Seed attachment was positively related to plant height, and bristle and hooked seed appendages, whereas it was negatively related to winged appendages, seed mass, and round seed-shape. However, also species without specific seed traits supposed to enhance epizoochory, attached some seeds on the fox, and our results support the view that a wide range of seed types can be dispersed in the fur of mammals [2]. In summary, the results suggest that red fox can be an important seed dispersal vector in the agricultural landscape.

Table 1. Seed attachment in different species. I_{seed} is the number of seeds on the fox dummy divided by seed density (1000 seeds m^{-2}) in the vegetation. I_{seed} is given as mean with 95% confidence interval (n=10).

	I_{seed}	
Species	mean	95% CI
Geum rivale	537.3	80 - 1340
Festuca ovina	349.2	100 - 660
Leucanthemum vulgare	311.6	0 - 930
Deschampsia cespitosa	78.4	59.9 - 99.4
Ranunculus acris	38.3	27.7 - 50.6
Anthoxanthum odoratum	38.2	20.7 - 54.6
Carex pallescens	17.0	9.9 - 24.8
Luzula multiflora	16.4	9.4 - 24.9
Rumex acetosa	12.1	9.2 - 15.6
Agrostis canina	8.3	3.1 - 13.5
Festuca rubra	6.2	1.2 - 11.2
Nardus stricta	4.5	0.0 - 9.0
Carex panicea	2.4	0.6 - 4.2
Rhinanthus minor	2.1	0.2 - 4.5
Agrostis capillaris	2.0	1.3 - 2.8
Potentilla erecta	0.8	0.2 - 1.4
Bistorta vivipara	0.6	0.0 -1.8
Poa pratensis	0.5	0.0 -1.3
Viola canina	0.5	0.0 -1.6

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A spatially explicit simulation model for analyzing butterflies' movement paths

Ádám Kőrösi (1), Annamária Szabó (2), Noémi Örvössy (3), Péter Batáry (4) & László Peregovits (3)
(1) Animal Ecology Research Group of Hungarian Academy of Sciences & Hungarian Natural History Museum, Ludovika tér 2., 1083 Budapest, Hungary
(2) Department of Animal Systematics and Ecology, Eötvös Loránd University, Pázmány Péter sétány 1/C, 1117 Budapest, Hungary
(3) Department of Zoology, Hungarian Natural History Museum, Baross u. 13., 1088, Budapest, Hungary
(4) Agroecology, Georg August University, Waldweg 26, 37073 Göttingen, Germany

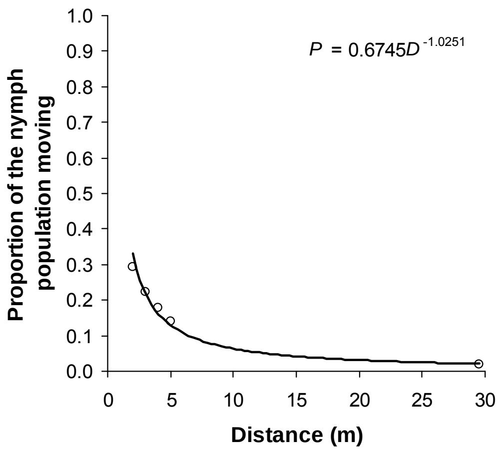
Studying populations' spatial structure on a landscape scale is essential in order to make appropriate recommendations on management for nature conservation. Distributional pattern of populations on a landscape scale is a result of movement behaviour of individuals. Individuals' movement can be influenced by various factors, such as resource distribution, habitat fragmentation, boundary permeability of habitat patches or several life-history trade-offs. There is an increasing knowledge regarding these effects in highly fragmented landscapes, but it is still unclear how these factors affect animals' movement in less-fragmented landscapes. We aimed to analyze the movement pattern of a butterfly species in a less-fragmented landscape consisting of four different habitat types. We found considerable differences among the habitat types, but it was difficult to characterize the butterflies' movement pattern by the simple random walk model. Hence, we developed a simulation method that could take into account the shape and size of habitat patches and the differences in permeability of boundaries. Our study species was the Southern Festoon (*Zerynthia polyxena*, Lepidoptera: Papilionidae). Its only larval food plant is a nitrophilous weed, Birthwort (*Aristolochia clematitis*). Populations of the butterfly can be detected at any places wherever the food plant is present. Our study site was in a mosaic landscape comprising of poplar and black locust plantations, clearings and hummocks. Male butterflies were tracked, their movement paths were dissolved into consecutive straight moves. We could assign a distance, a direction, a duration to each move and a habitat type where it was performed. Altogether 819 moves of 45 butterflies were sampled. On the habitat type level we found that move distances were significantly longer and move speed was higher in the woodland habitats than in clearings and hummocks. On the level of individual paths, we tested the appropriateness of the random walk model. First we checked whether the assumptions of the model were fulfilled, then we plotted the net squared displacement ($R_n(2)$) against the number of moves (n) for each observed subpath separately. Then we simulated 1000 pseudopaths to each observed subpath by keeping the move distances fixed and having the turning angles from a uniform distribution. 95% confidence intervals of $R_n(2)$ were obtained by discarding the smallest and largest 25 values for each n. We found that the random walk model underestimated $R_n(2)$ for ~50% of all paths. Therefore, we improved the simulation procedure by involving the exact shape and size of all habitat patches as well as modelling butterflies' behaviour at habitat boundaries based on our observations. Thus, the model became suitable for testing the effects of different movement rules, patch geometry and boundary permeability on the movement pattern of individuals. The possible explanations of the observed movement pattern and further implications of the model are discussed in the presentation.

Dispersal ability of a woodland invertebrate: a case study of wood cricket (*Nemobius sylvestris*)

Niels C. Brouwers
Bournemouth University, School of Conservation Sciences; Talbot Campus, Fern Barrow, Poole, Dorset, BH12 5AA, UK

Conservation efforts increasingly focus on the creation of habitat networks in order to reverse the negative effects of fragmentation by increasing the level of connectivity between habitat patches within anthropogenic landscapes. Creating habitat networks is thought to reduce the possible negative effects of climate change that might cause a shift in habitat conditions, by facilitating the dispersal of organisms through the landscape. In the UK, several initiatives have focused on the creation of habitat networks for woodland habitat. However, our understanding of the dispersal ability of species associated with woodland is severely lacking. Therefore, a study was undertaken examining the dispersal ability of the woodland invertebrate wood cricket (*Nemobius sylvestris*) on the Isle of Wight, UK. A series of experiments were carried out where juvenile (nymphs) and adult wood crickets were released and observed over time within different habitat environments. This investigation found that: (1) population spread of wood cricket nymphs and adults (males and females) could be accurately described by the inverse-power equation (Figure. 1); (2) wood crickets were capable of traversing up to 55 m away through non-woodland (e.g. semi-natural grassland) habitat; (3) nymphs and adults were equally able to cross barriers such as a water course; and (4) adults were able to orientate themselves up to 40-50 m towards a woodland edge. These results indicated relatively good dispersal ability for this small flightless invertebrate species.

Wood crickets were further found to use mature corridor features, indicating that the ongoing investment and efforts in creating woodland habitat networks has the potential to facilitate the spread and population viability of wood cricket, given enough time.



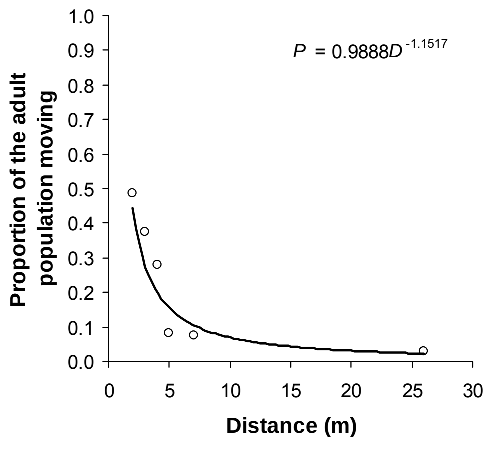


Figure 1: The proportion of the wood cricket population observed moving over 96h after release fitted against distance. Inverse-power curves are fitted to the data. (a) Nymphs: curve fit; $R2 = 0.993$, $F_{1,4} = 446.0$, $P = 0.000$. (b) Adults: curve fit; $R2 = 0.867$, $F_{1,5} = 26.04$, $P = 0.007$. Inverse-power equation: P = proportion of the population moving, D = distance (m).

Habitat characteristics and species traits determine ballooning propensity of spiders

Martin Schmidt & Karin Stämpfli
University of Bern, Community Ecology; Baltzerstrasse 6, 3012 Bern, Switzerland

Propensity for long-distance dispersal should depend on habitat characteristics and species traits. For example, spiders from disturbed habitats should be ready to balloon in order to escape from adverse conditions. On the other hand, spiders from rare habitat types are expected to balloon less, because the chance to find a new suitable habitat patch is lower than for species inhabiting widespread habitat types. Species should balloon more if they are habitat generalists and/or if they are common, because the chance to land in a suitable place is higher in both cases. We tested these predictions by measuring ballooning propensity of 1316 spider individuals in a wind channel. The spiders came from 16 habitat patches and belonged to 144 species, which varied with respect to the attributes described above. On the habitat level, ballooning propensity increased strongly with habitat disturbance, but not with habitat commonness. On the species level, ballooning propensity could be explained by species commonness, but not by the degree of habitat specialization. Ballooning propensity of spiders appears to evolve rapidly towards favorable levels both with respect to habitat characteristics and species traits.

Paradoxical meta-population response to habitat improvement.

Hans J. Poethke (1), Calvin Dytham (2) & Thomas Hovestadt (1)
(1) Field Station Fabrikschleichach, University of Würzburg, D-96181 Rauhenebrach, Germany
(2) Department of Biology, University of York, PO Box 373, York YO10 5YW, UK

Many species are threatened by fragmentation and degradation of their natural habitats [1]. The negative human impact on the survival of populations may sometimes be aggrevated by rapid evolution over ecological timescales [2]. This type of "evolutionary suicide" has been described by theoretical as well as empirical studies [3]. However, so far no mechanism has been reported where the improvement of habitat triggers an evolutionary response that will finally result in a decline of population size. We use individual-based simulations of metapopulation dynamics to demonstrate that measures taken to improve metapopulation persistence, like an increase in the quality, size, or stability of some of the habitat patches in a metapopulation, may ultimatelly lead to a reduction in the number of patches occupied and a decline in overall population size.

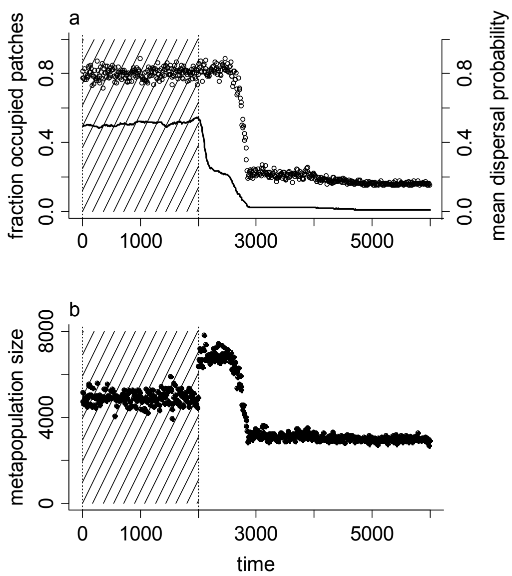


Figure 1
Example of the effect of partial patch improvement (at t=2000 a fraction of 15% of the patches of a meta-population were improved: capacity was increased from 50 to 100 individuals and the frequency of externally induced local extinctions was reduced from 0.2 to 0.
a) fraction of occupied patches (open circles) and mean emigration probability (line).
b) total metapopulation size .

When habitat management successfully improves the quality or carrying capacity and/or reduces local extinction probability of a fraction of habitat patches in a fragmented landscape, animals may adjust their dispersal behavior to the favorable conditions (Fig. 1a). The resulting decline in dispersal propensity may result in the extinction of local populations in the remaining unimproved patches (Fig 1a), which are not recovered by the flow of immigrants anymore. Consequently, a severe reduction in metapopulation size may occur (Fig 1b). We conclude that conservation efforts that ignore potential evolutionary consequences of habitat management may in certain circumstances increase the extinction risk of populations [4].

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Can long-distance seed dispersal respond to natural selection?

Frank Schurr
University of Potsdam, Department of Plant Ecology and Nature Conservation; Maulbeerallee 2, D-14469 Potsdam, Germany
Université Montpellier , Institut des Sciences de l'Evolution (ISEM); Place Eugène Bataillon, F-34095 Montpellier, France

Long-distance seed dispersal (LDD) is of paramount importance for the large-scale and long-term dynamics of plants, and for their ability to respond to future environmental change. Moreover, LDD has large fitness consequences suggesting that it should be subject to strong natural selection. However, a widely accepted dogma of plant ecology states that LDD cannot respond to natural selection because it results from chance events over which plant phenotypes (and hence genotypes) exert no control.

Here I re-examine this dogma by making use of the exceptionally good knowledge we have on the seed dispersal and macroevolution of Proteaceae from the South African Cape Floristic Region. In a comparative study of 35 species of Proteaceae, I combine mechanistic models for seed dispersal by wind with species-specific measurements of dispersal traits and a molecular phylogeny.

This combination of data and mechanistic models is then used to address four key questions about LDD evolution:

1) To what extent is variation in LDD driven by variation in dispersal traits rather than environmental variation?

2) Is LDD merely a by-product of short-distance dispersal or could it evolve independently?

3) To what extent do covariances between dispersal traits constrain LDD evolution?

4) Has LDD responded adaptively to natural selection?

Finally, I place the results in the context of a review on LDD mechanisms to assess to what extent the results obtained for Cape Proteaceae can be generalized to other plant species.

Decision making and information-use by riparian wolf spiders during water surface locomotion

Kevin Lambeets (1) & Dries Bonte (2)
(1) Ghent University, Dep. Biology, Terrestrial Ecology Unit (TEREC), KL Ledeganckstraat 35, 9000 Ghent, Belgium;
(2) Würzburg University, Field Station Fabrikschleichach, Glashüttenstrasse 5, 96181 Rauhenebrach, Germany.

Movement decisions of specialist species that regularly experience risky situations (e.g. detrimental disturbances) are expected to provoke beneficial behaviour. Species without *a priori* knowledge of actual risks and benefits of any particular movement choice are, however, expected to show more behavioural variability with potentially non-adaptive decisions. Predominantly, these movement decisions are taken by making use of information, which is gained at different spatial and temporal scales. Therefore, we expect species differing in their degree of habitat specialization to use different sources of information in the expression of movement behaviour. This was tested by comparing movement decision making (homeward orientation) and mobility (movement duration) of two closely related wolf spider species (Lycosidae; genus *Pardosa*) from river banks during water surface locomotion under field conditions. Variation partitioning showed the overall importance of population of origin during homeward orientation. Variability on the individual level explained behavioural variation largely for a specialist wolf spider, not for a generalist. Residual variation was higher for a generalist species, and increased when analyzing movement duration. Analyzing homeward orientation in more detail showed adaptive behaviour of individuals according to their population of origin, while interspecific differences or effects of weather conditions were less clear. Moreover, sex was shown to explain variation in orientation for a generalist species. Variation in movement duration was best explained by sex regardless of the species, besides with increasingly importance of weather conditions. Moreover, the population of origin was still retained as significant for a specialist. Our results indicate that a specialist wolf spider species is more reluctant to rely on sampling information (experience) and making beneficial decisions on an individual basis. Experience seems to affect decision making of a wolf spider generalist, nevertheless, individuals would rely more on prior information (e.g. sex). Regardless of habitat specialization, the importance of acute information for movement decision making increases when decisions are more costly (cf. mobility).

Tracking resources and mobility in changing landscapes: integrating life history theory into conservation biology

Hans Van Dyck
Behavioural Ecology & Conservation group, Biodiversity Research Centre,
Université catholique de Louvain (UCL), Croix du Sud 4-5, B-1348 Louvain-la-Neuve, Belgium

Anthropogenic-induced environmental changes like habitat fragmentation may impose evolutionary challenges for indigenous species. The recognition of functional habitat should be based on a resource-based approach [1]. Dispersal to track resources is widely recognised to be a key process for demography and, hence, also for conservation biology. However, dispersal has often been treated by ecologists as a species-specific fixed trait. But evidence against this assumption is accumulating as I will show for a frequently used model group in ecology and conservation biology, butterflies.

In butterflies, there is a growing body of evidence for intraspecific differences between populations relative to landscape structure. Movements are associated with different functions and not exclusively with dispersal. This multifunctional nature complicates the use of simple dispersal proxies. Moreover, expert opinion may result in a biased vision on mobility. Dispersal ability has often been underestimated. Mark-release-recapture studies show patterns of movements, but they do not provide insight into the behavioural mechanisms.

Understanding the mechanisms is, however, significant for conservation. Dispersal through a landscape can be realized in two major ways: as a by-product of daily routine movements or as specific movements designed for displacement [2]. Both types have different characteristics and consequences. Dispersal should be considered a three-stage process (emigration, transfer, immigration) as environmental factors may affect each stage differently. Hence, dispersal ability includes more than flight ability per se. Recent behavioural experiments show the significance of perceptual range [3]. Movements are the result of multiple interactions between the organism and its environment. Therefore, it is the functional grain of a landscape rather than the structural grain that is key to better understand movements [4].

Butterfly movements (and dispersal in particular) need to be examined within a life-history context. I will illustrate this with results from a common garden experiment showing the differential effects of increased flight on the reproductive performance of female speckled wood butterflies (*Pararge aegeria* L.) from closed continuous woodland landscape vs open highly fragmented agricultural landscape. Changes in landscape structure may impact on life history traits including mobility and reproductive performance, and their trade-offs.

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The ecology and evolution of dispersal in wetland plants: adaptations to find the right sites for germination and growth?

Merel Soons (1), Arjen de Groot (1), M. Teresa Cuesta Ramirez (1,2) & Jos Verhoeven (1)
(1) Utrecht University, Landscape Ecology Group, Sorbonnelaan 16, 3584 CA Utrecht, the Netherlands
(2) University of Córdoba, Edificio C-4, Celestino Mutis, Campus de Rabanales. 14071-Córdoba, Spain

In sessile organisms such as plants, the dispersal of propagules away from the parent is essential for generating spatial population structure, maintaining spatial (meta-) population dynamics and colonizing new areas – for example, in migration following climatic changes. In higher plants, the seed or fruit (from here on grouped under the term ‘seed’) is typically the propagule that disperses. Plant species around the world produce seeds in varying, often (very) large, numbers and in varying seed sizes, in many cases with morphological adaptations for their dispersal. These investments in dispersal of seeds indicate that some fitness benefit is expected from seed dispersal. Not all dispersed seeds will reach sites suitable for germination and establishment, and plants can increase their fitness by increasing the proportion of seeds that are dispersed to sites where they have a predictably high probability of germination and growth. Such disproportionate dispersal to suitable sites is known as ‘directed dispersal’ and has previously been shown to occur in some animal-dispersed plant species. It may, however, be a more widely spread phenomenon in the plant world, including also seed dispersal by other dispersal vectors such as water or wind.

Water and wind are very common and widely available dispersal vectors. If they disperse seeds specifically to suitable sites then directed dispersal may play a far more important role in ecology than previously thought. We investigated whether seed dispersal by water and wind disperses seeds predominantly to suitable sites in wetlands. Many wetlands are dynamic, spatially heterogeneous ecosystems where wind and water are among the most widely available dispersal agents. Our study shows that wetland plants may have evolutionary adaptations that facilitate dispersal to suitable wetland sites by water and wind, thereby significantly enhancing the success of seed dispersal. Such adaptations indicate that the seed stage and the seed dispersal process may contribute much more significantly to the fitness of wetland plants than previously thought - and likewise play a much more important role in wetland plant ecology. In other dynamic and spatially heterogeneous ecosystems, common seed dispersal vectors may perform the same function and their potential ecological importance should not be overlooked.

Seed dispersal patterns in heterogeneous landscapes: spatial and genetic consequences at early recruitment stages

Cristina García (1,2), Sylvie Oddou (2) & Etienne Klein (3)
(1) Plant Biology Department, 2512 Plant Sciences, 30602, Athens, Georgia (USA)
(2) Unité de Recherches Forêst Méditerranéennes. Domaine Saint Paul, Site Agroparc. 84914 Avignon (France)
(3) Unité de Biostatistiques et Processus Spatiaux. Domaine Saint Paul, Site Agroparc. 84914 Avignon (France)

Seed dispersal is documented to limit recruitment patterns when failing to reach all suitable available sites in the population usually due to distance limitation [1]. There is growing evidence, based on field studies, that vertebrate-generated seed rain patterns show increased complexity in heterogeneous landscapes. Frugivores tend to select certain source trees and deposition sites according to their foraging requirements, and as a result, seed rain patterns become strongly influenced by the ecological heterogeneity [2]. Non-random seed dispersal patterns driven by frugivores in heterogeneous landscapes derives in a source-biased and a spatial limitation [2], and therefore, pervasive consequences in the genetic composition and its spatial structure are expected at early recruitment stages for vertebrate-dispersed species inhabiting heterogeneous landscapes.

Our study aims at characterizing the spatial and genetic composition in the seedling rain resulting from non-random dispersal patterns in different ecological scenarios with distinctive heterogeneity patterns and recruitment conditions. Firstly, we develop a spatial explicit, individual-based model to simulate dispersal events and generate seed rain patterns under different ecological scenarios. The level and the distribution of the ecological heterogeneity in the landscape define distinctive ecological scenarios. Then, we apply different recruitment curves based on the probability of dispersed seeds to be recruited as a function of seed density and distance from the source tree. We hypothesize that the genetic composition and its spatial structure observed in the seedling rain yield predictable complex patterns insufficiently explained by distance limitation and strongly context dependent. We compare the effective seed dispersal distance kernel (i.e., obtained after recruitment) and the actual seed dispersal kernels (i.e., previous to recruitment) and assess the effective number of contributing trees and the spatial genetic structure for each ecological scenario in order to dissect the effect of dispersal and recruitment processes in determining genetic and spatial features in the seedling rain. Finally, we discuss our results providing a comprehensive understanding of the role of seed dispersal in determining genetic and recruitment patterns in vertebrate-dispersed plant populations inhabiting highly heterogeneous landscapes.

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Dispersal contributions to plant survival and invasion in changing landscapes

Eelke Jongejans
Radboud University Nijmegen, Toernooiveld 1, 6525 ED Nijmegen, The Netherlands

Dispersal is a key component of the life history of both invasive plants and plants that have declined in abundance. How important dispersal is for e.g. invasion speeds or survival in fragmented landscapes can be studied with detailed spatial population models: what are the effects of native-invaded range differences and of landscape and climate change on seed dispersal and consequently on the changes in abundance of plant species? Examples of such studies on plant invasion and on plant survival are given below.

Plant invasion: The invasive thistle *Carduus nutans* shows different spatial population dynamics in its native and invaded ranges. Spatial integrodifference models that combine structured, local population models with mechanistic (WALD) models of seed dispersal by wind across a homogeneous landscape were used to analyze the contributions of the changes in demographic rates and dispersal parameters to the increases in the invasion wave speed (c*) estimates for the different invaded ranges (Australia, New Zealand, USA) compared to that for the native range (Eurasia). This c*-LTRE analysis showed that the net contribution of the dispersal parameters to c* increases varied among the populations from 51% to 85%. This approach can thus be used to analyze which aspects of an invader's life history have changed most importantly from the native range.

Plant survival: Many floodplain plant species in the Netherlands have declined in abundance over the past century due to habitat loss and reductions in dispersal via waterways. Furthermore, climate change, through higher temperatures in the Alps and increased precipitation in winter, will continue to significantly affect the survival of populations with altered flood timing, duration and frequency. On a positive note, many plant species show signs of resilience, delaying local extinction for long but finite periods. Plastic expression of e.g. flood tolerance and seed dispersal related plant traits is an important mechanism of such resilience, but the direct and indirect consequences of phenotypic plasticity for population dynamics are poorly understood. It is therefore necessary to study population dynamics under past, present and a range of future climate regimes and landscape use scenarios with spatial population models that hierarchically incorporate environment-trait, trait-trait and trait-life history relationships.

Complementary sex determination and the survival of haplo-diploid insect populations in spatially structured landscapes

Silke Hein (1), Hans-Joachim Poethke (2) & Silvia Dorn (1)
(1) ETH Zurich, Institute of Plant Sciences/Applied Entomology, Schmelzbergstr. 9/LFO, CH-8092 Zurich, Switzerland
(2) University of Wurzburg, Field Station Fabrikschleichach, Glashüttenstrasse 5, D-98616 Rauhenebrach, Germany

Social and non-social hymenopteran populations such as pollinators (honeybees, bumble bees, solitary bees) and parasitoid wasps are at increasing risk. Extinction risk is based on the interplay of the insects' sex determination mechanism and the spatial subdivision of populations due to increased habitat fragmentation. Hymenoptera are haplo-diploid, i.e. males develop from unfertilized (haploid) eggs and females from fertilized (diploid) eggs. Complementary sex determination (CSD) is ancestral and prevailing in Hymenoptera. Under CSD, fertilized eggs, which are heterozygous at one or several sex loci, develop into females whereas homozygous eggs become additional (diploid) males. As a result sex ratio shifts and diploid males, which have disadvantages such as that they are sterile, change population composition. Habitat fragmentation increases the probability of diploid male production (DMP) due to a higher probability of inbreeding.

Consequences of DMP on the survival of populations have been studied empirically in tests of inbred laboratory populations. From theory, one study focusing on single, small and isolated populations is available and predicts an increase in the extinction risk of populations by an order of magnitude due to DMP. Studies testing factors and factor combinations to avoid or overcome negative effects of DMP at metapopulation level or in spatially structured populations are missing.

We present a simulation study focusing on a spatially structured population of a hymenopteran model species exhibiting CSD. We investigate populations in which homozygous diploid individuals are either inviable (e.g. honeybee) or survive as diploid males (e.g. many parasitoid wasps). For certain demographic conditions and landscape constellations DMP may indeed result in extreme extinction risk. However, we show that in spatially structured populations extinction risk is strongly influenced by demographic factors such as fecundity, competition and sex ratio. Especially, inter-population dispersal even at a very low rate may severely reduce the influence of DMP on the extinction of metapopulations.

Evolution and local adaptation of dispersal distance in heterogeneous landscapes

Dries Bonte (1,2) Thomas Hovestadt (1) & Hans-Joachim Poethke (1)
(1) Würzburg University, Field Station Fabrikschleichach, Glashuettenstrasse 5, D 96181 Rauhenebrach, Germany
(2) Ghent University, Dep. Biology, Terrestrial Ecology Unit, K.L. Ledeganckstraat 35, BE-9000 Ghent, Belgium

In natural landscapes, the quality, density and distribution of habitat typically varies across space. This landscape configuration will largely induce selection on dispersal in organisms for which risks to end up in unsuitable habitat are prominent, e.g. seeds, ballooning arthropods. Surprisingly little is known on how changes in landscape configuration (i.e., the availability, quality and spatial autocorrelation) and disturbance affect the evolution of dispersal distance. Based on individual-based simulations for passively dispersing organisms with discrete generations in fractal landscapes we show that habitat fragmentation (decreased autocorrelation) has a stronger effect on the evolution of dispersal distance compared to habitat reduction (see Fig. 1). Changes in dispersal distance are mediated by shifts in dispersal kernel type and kernel properties. Long distance dispersal predominantly evolves in spatially uncorrelated landscapes with high degrees of disturbance. Local adaptation in dispersal strategies is largest in landscapes that select against global dispersal and is related to local habitat availability. Thresholds for the evolution of local adaptation in response to landscape properties and disturbance rate are, however, observed.

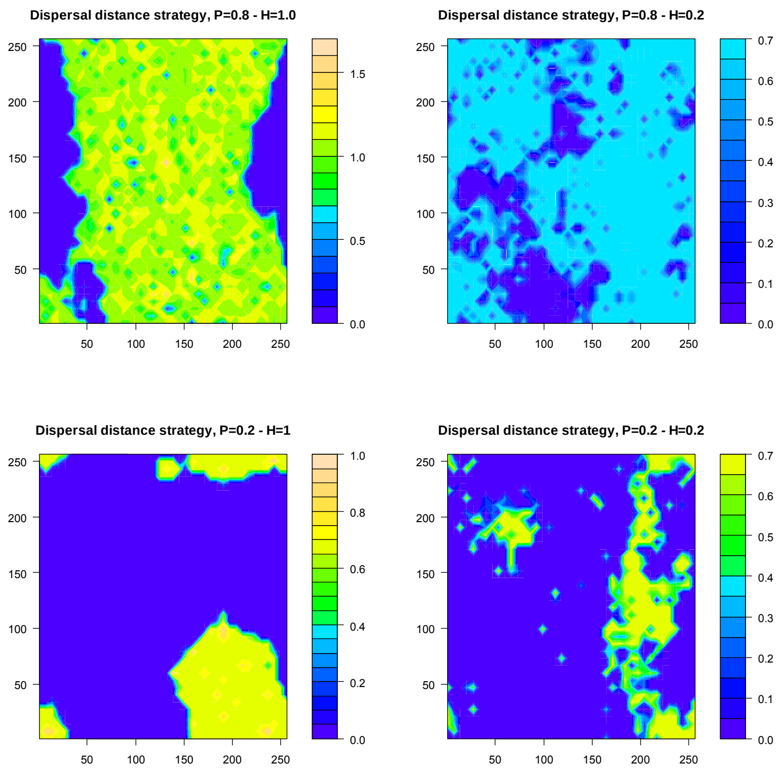

Fig 1: Evolution and local adaptation of dispersal distance in landscapes with different proportions of suitable habitat P (resp. 80% and 20%) and level of spatial autocorrelation H (resp 1 and 0.2). High trait values indicate potential for larger dispersal distances. Purple colours: matrix.

Note increased selection for increased dispersal distance in landscapes with higher frequency of habitat and higher degree of autocorrelation.

Theory beats pragmatism: A comparison of different models for density-dependent emigration

Thomas Hovestadt, Alexander Kubisch & Hans-Joachim Poethke
University of Wuerzburg, Field Station Fabrikschleichach, Glashuettenstrasse 5, 96181 Rauhenebrach

There are strong empirical and theoretical arguments suggesting that density-dependent dispersal occurs and that it is an adaptive strategy. This principal declaration does, however, not constitute how individuals should quantitatively respond to density in their emigration decisions. Throughout the literature a considerable number of functional links between density and emigration probability can be found, which were largely conceived based on pragmatic considerations and not from first principle.

In this talk we compare the performance of four different density-dependent dispersal strategies [1-4] as well as density-independent emigration in direct pair wise evolutionary competition. We use individual-based simulations of metapopulation dynamics and conduct competition experiments for different combinations for dispersal mortality and environmental stochasticity. For each setting of external conditions, the strategies are first allowed to evolve optimal parameter values in isolation. Competition experiments are then initialized taking 50% of the individuals from such a population evolving with one strategy and 50% from a population evolving with the competing strategy.

As expected, we find that a single-parameter "asymptotic threshold" strategy [3] derived from the principle of the "ideal-free distribution" decisively out-competes any other strategy in pair wise competition, i.e. density-independent emigration, a "linear threshold" strategy and a highly flexible sigmoid strategy. A simple threshold strategy [2] derived from the same principle as the winning strategy but applicable for the case of continuous population growth only, performs even worse than the density-independent strategy.

The type of the dispersal strategy (function) used in simulation experiments affects predictions concerning the survival of populations, their range expansion, respectively shrinkage, or community changes. We thus clearly recommend the use of theoretically founded functions to model density-dependent dispersal.

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Poster presentations

Explicit seed dispersal distances of silver fir (*Abies alba* MILL.) determined by genetic fingerprinting of seed coats

Eva Cremer (1,3), Katrin Schulerowitz (1) (both authors equally contributed), Karl-Heinz Rexer (2), Ronald Bialozyt (1), Birgit Ziegenhagen (1) & Sascha Liepelt (1)
(1) Philipps-University of Marburg, Faculty of Biology, Conservation Biology Group, Karl-von-Frisch-Str. 8, 35043 Marburg Germany
(2) Philipps-University of Marburg, Faculty of Biology, Mycology Group, Karl-von-Frisch-Str. 8, 35043 Marburg Germany
(3) Present address: Bavarian Institution for Forest Seeding and Planting, Forstamtsplatz 1, D-83317 Teisendorf, Germany

Forest ecosystems are characterized by high levels of genetic diversity in their foundation species, namely forest trees. Due to their long generation times the mechanisms of maintaining genetic diversity are difficult to study. It is reasonable to assume that processes of pollen and seed dispersal play a major role in the spatio-temporal dynamics of genetic diversity. Explicit information about seed dispersal is scarce for the majority of species.

In this study we were interested in the seed dispersal of silver fir (*Abies alba* MILL.) which is a forest tree of major ecological importance in the Black Forest, Germany. The study area is characterized by large windbreaks caused by the storm "Lothar" in 1999. In order to study seed dispersal both in closed stands and on open windbreaks, a grid of 30 seed traps was installed partly on a windbreak site and partly in a closed stand of mixed forest of fir, spruce and beech. The majority of adult silver firs in this stand had been geo-referenced and genotyped in a previous study.

Over a period of 14 weeks, 674 silver fir seeds were successfully captured from September 2006 to January 2007. The seeds were weighed, measured and dissected to determine whether a vital embryo was inside. The seed coat and wing of each seed, resembling tissue of the mother plant, were genotyped with nuclear microsatellites. Since these genotypes directly resemble the respective mother tree an assignment of seeds to their mother trees became possible. This allowed us to explicitly determine dispersal distances and relate them to seed properties and to the position of mother trees in the stand.

The results will be used to gain further insights into the dynamics of silver fir populations and to develop practical recommendations for dealing with the consequences of an increasing number of devastating windstorm events during the predicted course of global change.

Seed rain vs. seed bank in a steppe perennial *Senecio macrophyllus* during grassland overgrowing

Bożenna Czarnecka & Joanna Czarnecka ,
Maria Curie-Skłodowska University, Department of Ecology, Akademicka Str. 19, 20-033 Lublin, Poland; e-mail: [1]bozennaczarnecka@interia.pl

The seed rain, that is, the flux of seed (or other propagules) into and out of a unit of habitat determines the potential population of that habitat [2]. Among the most important traits affecting the seed rain amount there are: the share of genets (ramets) reaching the reproductive stage in a population, number of generative episodes during the individual life span, genet size and fecundity. The store of seeds buried in soil (the seed bank) represents a vast dormant population accumulate over the years. Viable, dormant seeds can be regarded as a "deposit account".

The model object was a rare, steppe ragwort, *Senecio macrophyllus* M. Bieb. (formerly *S. umbrosus* Waldst. et Kit.), Asteraceae. It is a large, long-lived, iteroparous plant occurring only at several localities in southeastern Poland and in western Ukraine [1]. One of the species' island populations, on Biała Góra (White Mt.), has been studied since 1989. During the study period the process of open xerothermic grassland overgrowing by bushes consisted of *Prunus spinosa*, *Cornus sanguinea*, *Rhamnus catharticus, Rosa* spp. has been observed. It was accompanied by the increasing coverage of grasses, mainly *Brachypodium pinnatum* and *Calamagrostis epigejos*. Simultaneously, the share of *S. macrophyllus* has been decreased.

The present study focused on the following aims: (i) to assess the population density and variability of share of reproductive genets and individual fecundity, that affects the seed rain in a population; (ii) to find out whether changing habitat conditions enable the formation of permanent soil seed bank. The density and life stage structure of the population were studied many times, both by surface method (12 times during the period 1990-2007) and non-surface one (5 times, see Fig. 1). The genet fecundity was evaluated 3 times (1990, 2003, 2006), while the soil seed bank studied by seed extraction method – 5 times (1998-2001, 2004). In years 1990 and 2003 the seed rain was at the level of 1 922 and 2 600 thousands seeds per 1 hectare, respectively, and then suddenly dropped to only 965 thousands per 1 hectare in 2006. In this time the seed deposit in soil decreased from 1054 to 61 seeds per 1 m^2.

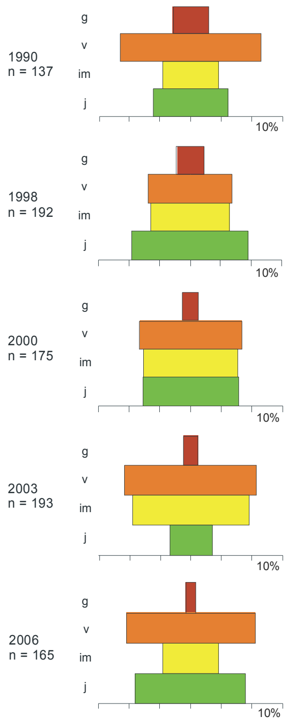

Figure 1: The life stage structure of the *Senecio macrophyllus* population; n – number of ramets;

j, im, v, g – ramets

in juvenile, immature, mature vegetative

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Mucilage segregation in seeds of Angiosperms: hypothesis about its function and origin

Meike Engelbrecht & Patricio García-Fayos
Centro de Investigaciones sobre Desertificación -CIDE- (CSIC-UV-GV) 46470 Albal (Valencia, Spain)

Mucilage production in seeds and fruits after wetting is a common feature in many families of Angiosperms. It has been proposed to be an adaptation in the development of seeds in relation to their environment as it can favor seed dispersion, anchorage to the ground or germination. Mucilage in the seed is segregated in the testa or the pericarp on wetting and can therefore be specified according to its origin. Following Ryding [1], myxodiaspory is the condition of having mucilaginous diasporas and can be used for either mucilage producing fruits or seeds. The diaspora therefore produces a more or less tick mucilaginous layer once it has come in contact with water, imbibing the outer cell layer completely and releasing the mucilaginous substance.

The function of the mucilage segregation of seeds has different hypothesis, depending of the genera and species. Generally there are two main concepts: first as an aid for water absorption of the seed coat or the seed, facilitating or inhibiting germination, and secondly in relation to the adhesion of the diaspora, functioning as a dispersal mechanism or in the opposite as anchoring devise sticking the seed to the ground. The question of one single function for all species where mucilage segregation in seeds occurs might be difficult to answer as the issue of its origin has not been resolved. It also could be assumed that, if the mucilage segregation in seeds can be found in diverse plant families of the angiosperm family tree, the actual origin within the clade is the same and could be identical by descent. The special character might have been lost in some branches of the clade as it has been conserved in others. But shared ancestral characters do not always reveal phylogenetic relationship. Mucilage segregation therefore could have been evolved as an adaptation to a similar environment, as convergent or parallel evolutionary change can lead to phenotypic similarities among the members of a guild that are not close relatives. After reviewing bibliographic information and data-bases, 39 literature evidences about the mucilage function were found. In these works 72 times seed dispersion was the mentioned as a hypothesis about the functionality of myxodiaspory and 40 times seed germination facilitation. Epizoochoire was one of the principal functions mentioned. Some other authors, on the other hand, link mucilage segregation with the anchorage of seeds to the ground implicating an advantage in environments where plants and their diasporas are exposed to the hazard of erosion. Stating germination as a principal question of myxodiaspory, mucilage segregation has been mostly related with the germination of seeds. Mucilage facilitates water diffusion from the substrate thus increasing the number of pathways and seed surface area through which water can be absorbed. Seeds with copious mucilage showed a much lower sensitivity to water tension as seeds with no mucilage segregation. Germination inhibition in contrast was stated by some authors who argue in their works that the mucilaginous layer might inhibit germination of the seeds as it makes them impermeable to oxygen and other gases.

Abstract too long/cut

Changes and impacts on coastal ecocsystem of touristic land use decisions in Cesme Peninsula

Nurdan Erdogan (1), H. Ece Salali (2), Umit Erdem (3) & Serdar Selim (4)
(1) Ege Universty Centre For Environmental Studies, 35100 Bornova,Izmir, Turkey
(2) Ege Universty Agricultural Research Center, 35100 Bornova, İzmir, Turkey
(3) Ege University Centre For Environmental Studies and Ege University Faculty of Agriculture Department of Landscape Architecture, 35100 Bornova, İzmir, Turkey
(4) Ege Universty Centre For Environmental Studies, 35100 Bornova,Izmir, Turkey

Since human started to control fire and domesticated plants animals, land use/land cover changes have occurred at all times, are presently ongoing and are likely continue in the future in all parts of the world. These changes are known and undisputed aspects of global environmental changes and have important impacts on biodiversity, climate, etc. For that reason, over the last few decades, numerous researchers have tried to measure land use/cover change, to understand causes of land-use change and to improve predictive models of land-use/cover change.

Cesme Peninsula is a good example to illustrate changes and impacts of land use decisions. Over the last decade, the peninsula becomes one of the most important touristic centers of Turkey. Because of increasing demand for tourism and unplanned and unrestrained evolution of touristic structure, specially on coastal areas, natural environment of the peninsula is under dense pressures. The aim of this study is to understand changes and its impacts on coastal ecosystem of land use/land cover changes between 1975-2005 and in Cesme Peninsula.

Ant-plant interaction: seed harvesting versus dispersal of a non-myrmechorous endangered plant in a fragmented habitat

Pablo Ferrandis, Esmeralda Martínez-Duro & José M. Herranz
University of Castilla-La Mancha, E.T.S. Ingenieros Agrónomos; Campus Universitario s/n4, 02071 Albacete, Spain

In spite of the complexity and diversity that ant-plant relationships can achieve, there is a general trend to consider seed harvesting as profitable (dispersal) or detrimental (predation) on plant populations only by attending to the existence or absence of myrmechory-adaptive seed traits, respectively. Such simplified view assumes that the unique fate of non-myrmechorous seeds harvested is consumption. However, the distinction of seed dispersal and predation by ants is not clear-cut.

Helianthemum polygonoides is a critically endangered non-myrmechorous chamaephyte endemic to Cordovilla salt-marsh reserve (200 ha; SE Spain). The habitat has been severely fragmented by agricultural intensification and urbanisation in last decades. The population occupies currently 16 ha overall. *Messor* and *Aphaenogaster* ants actively harvest fruits (dehiscent capsules) and seeds during the ripening and dispersal phase, which extends from June to September. The aim of the study was to weigh up accidental seed dispersal (i.e. diszoochory) against seed consumption, and to determine the actual impact of seed ant-harvesting on the viability of the fragmented plant population. We analysed (1) the diet of ants; (2) pre-dispersal predation of fruits as a function of distance to the ant-nest; (3) the fraction of the plant population visited by ants; (4) the seed shadow in absence and in presence of ants; (5) seed-carrying success and seed drops on foraging ant trails; (6) viable-seed rejection to refuse piles; (7) the persistence of the soil seed bank; (8) survival and age-class transition of individually marked plants. Finally, we incorporated results into an age-transition matrix analysis, in order to determine to what extent seed predation represents a bottle neck in the long-term viability of the fragmented population. Diet of ants was highly dependent on *Helianthemum* seeds during summer, when nearly no other food resource was available, particularly in the case of *Messor*. Seed predation by ants accounted for 80% of seed losses in plants visited. However, not all plants were predated with the same intensity. Seed shadow was dramatically reduced by seed ant-removal (over 15 times). Ants were highly successful in transporting *Helianthemum* seeds to the nest (seed or fruit drops on trails < 1%). Seed rejection to refuse piles was nearly negligible. In addition, recruitment of seedlings on refuse piles was null.

We conclude that seed harvesting does not contribute significantly to diszoochorous seed dispersal, in contrast to other recent studies. In spite of the high seed losses due to ant-predation, however, we detected a persistent soil seed bank. The population growth rate (λ) obtained from the analysis of a 5-year monitoring series indicated that the long-term viability of the *Helianthemum* population should be threatened by other factors different from seed harvesting, such as the spatial and temporal scarcity of safe sites.

Simulation of seed dispersal by two neo tropical tamarin species

Sebastian Flinkerbusch (1) ,Eckhard Heymann (2) , Marc Niggemann (1) & Ronald Bialozy (1)
(1) Philipps-University of Marburg, Institute of Biology; Karl von Frisch-Str. 8, 35032 Marburg, Germany
(2) German Primate Center, Kellnerweg 4, 37077 Göttingen, Germany

In tropical ecosystems seeds of various plant species are dispersed endozoochorous by vertebrates. Since Primates represent a major fraction of the frugivore biomass in several rain-forest communities they are considered to be the most important seed disperser in such ecosystems. Movement patterns of the seed disperser and the duration of the intestinal passage of the seeds causes the seeds shadow.

In order to answer the question if the movement patterns of primates lead to the observed seed distribution we developed a computer supported simulation model for seed dispersal by primates.

Our model is based on data of various studies which were accomplished under the patronage of the Deutsches Primaten Zentrum (DPZ) (1990-2003). The study site „Estation Biologica Quebrada Blanco“ (EBQB) is located in the north-east Peruvian lowland rainforest approximately 100 km south-east of the town Iquitos. Our study species *Saguinus mystax* and *Saguinus fuscicollis* are small nonhuman primates which belong to the genus *Calithrichidea*. Within the study area there are no other known seed dispersers of the pan tropic tree species *Parkia panurensis*. These two tamarin species live in small groups of three to nine individuals each in interspecific association. They swallow the seeds of *P. panurensis* to feed on the fibrous and adhesive pulp that surrounds them and defecate the seeds somewhere else.

In a first step we identified all relevant factors and processes which lead to the specific movement patterns of the tamarins. The position of species specific sleeping and feeding trees, their desire to find food and their individual marking and resting behaviour turned out to be the most important elements to describe their movement behaviour.

Afterwards we create an individual based simulation model to reproduce the daily moving routine of a group of the tamarins. We compared our simulated movement data with data from observations of free-ranging tamarins at the EBQB. Our model meets very similar day distances and home ranges (20 % -95 % fixed kernel), furthermore most of our simulations show a Gaussian distribution of day distances like the field data do. Therefore it seems to be deductive that it is possible to simulated movement patterns of tamarins adequately.

To complete our model we implemented a mean duration of the intestinal passage of *P. panurensis* seeds and we factored special defecation habits of the tamarins.

First simulation results of how the potential seed shadow of *P. panurensis* is influenced by the movement pattern of the tamarins will be presented.

How Do Dispersal Strategies and Landscape Features Interact? A Spatially Explicit Grassland Model

Jakob Gerstenlauer & Kerstin Wiegand
University of Jena, Institute of Ecology, Dornburgerstr. 159, 07743 Jena, Germany

Model Purpose.—The purpose of our model is i) to develop a conceptual framework that integrates measurable species traits into dispersal strategies, and ii) to understand better how species properties and landscape features result in observable spatial patterns of biodiversity. Finally, we seek to predict species-abundance distributions for a given species pool and landscape setting.

Scales and Model Structure.—The model describes stage-structured local populations and communities of grassland plants in landscapes consisting of 100 x 100 cells. Each cell represents a habitat within an area of 0.01 km^2 and may host local subpopulations of a number of species. Four types of habitats are represented: two grassland habitats, forest and arable land. The two grassland types represent i) high nutrient input and frequent disturbance management and ii) low input management with low disturbance intensity. Species Variables.—In order to prevent "super-species" with unrealistic trait combinations, species are a priori allocated to four dispersal strategies (Table 1) and three life forms. Generalist species reproduce in all habitats, specialists depend on specific grassland habitats. Habitat longevity is a species dependent feature of habitats: depending on the impact of management on plant survival and fertility the habitat may or may not serve for long-term growth and reproduction.

Table 1: Four dispersal strategies and hypothetically associated traits.

Dispersal strategy		Associated species traits			
Habitat longevity	Habitat frequency	Reproductive effort	Seed biomass	Seed number	Life forms
-	-	↑↑	↓↓	↑↑	Annuals, biennials
+	-	↑	↑	↑	Biennials, perennials
+	+	↓	↑	↓	Biennials, perennials
-	+	↑	↓	↑	Annuals, biennials

Habitat longevity: short-term (-) or long-term (+) survival and reproduction of individuals in the habitat. Habitat frequency: adaptation to rare (-) or common (+) habitat. Arrows indicate the hypothetical ranking of mean trait values between dispersal strategies: ↑↑ very high, ↑ high, ↓ low, ↓↓ very low. The range of possible life forms is restricted by the dispersal strategy of species.

Linear Matrix Model.—To analyze trade offs between species properties, they are randomized in the first stage of model development. For each randomly created species, a transition matrix for stage-structured meta-populations is created. This matrix incorporates dispersal probabilities, but assumes that local demography is not density dependent. The dominant eigenwert helps us to judge if the given species will survive in the landscape. With this matrix approach, we gain an analytical tool to map the range of viable species parameters for a given dispersal strategy and life form combination. In a next step, we are able to compare the viable parameter space of dispersal strategies between landscapes differing in the spatial distribution of habitats. Subsequently, we will build a multi-species model with density dependent local demography and compare differing initial species pools, landscape settings, and land-use scenarios.

Spatially explicit gene flow as mediated by seeds and pollen in a beech stand (*Fagus sylvatica* L.)

Natascha Hasenkamp, Christina Mengel, Georg Rathmacher, Birgit Ziegenhagen & Sascha Liepelt
Philipps-University of Marburg, Faculty of Biology, Conservation Biology, Karl-von-Frisch-Str. 8, 35032 D-Marburg Germany

The European beech (*Fagus sylvatica* L.) is the dominant wind-pollinated forest species over great regions of Europe. Since the beginning of the 19th century beech populations in Central Europe have been fragmented by conifer plantations Fragmentation is assumed to affect gene flow. In order to learn about such effects we urgently need knowledge about dispersal distances of seeds and pollen. As one of the first studies we analysed the spatially explicit gene flow in a beech stand, using microsatellite markers. The study site is a certified seedlot stand in the Rothaar-Mountains (North Rhine Westfalia, Germany) which covers an area of 8.7 ha. There, each five to six seeds were collected beneath 19 adult trees. Altogether, 101 seeds were collected as well as leaves of 334 adult trees including the 19 putative mother individuals. The trees were sampled in concentric circles around the putative seed sources which resulted in a nearly complete inventory of the stand. All samples were genotyped at six nuclear DNA microsatellite loci. The seed donors were attributed to the seeds comparing the multilocus genotypes (DNA fingerprints) of exocarps of the seeds with the leaves of the adults. The pollen donors were determined by means of paternity analysis given the maternal genotypes. First results indicate that there are many more than just the 19 putative mother trees. In general the study will provide information about dispersal distances of seeds and pollen. Thus it will provide a basis for recommendations for designing seed harvest strategies and a genetically based certification of seed sources.

The effect of translocation on movement behaviour of Orthoptera – a test for the assumptions of behavioural studies

Ina Heidinger (1), Silke Hein (2), Dries Bonte (1) & Hans-Joachim Poethke (1)
(1) University of Wuerzburg, Field Station, Glashüttenstr. 5, 96181 Rauhenebrach, Germany
(2) ETH Zurich, Institute of Plant Sciences/Applied Entomology, Schmelzbergstr. 9/LFO, 8092 Zurich, Switzerland

Dispersal, a key process for the ecology and evolution of animals, influences the distribution and coexistence of species as well as the diversity of species communities. It is essential for the stability and long term survival of populations by linking subdivided populations and regulating the gene flow between them.

Conclusions about dispersal are commonly based on the behaviour of artificially displaced individuals e.g. by mark and recapture studies, which are frequently used to receive movement data. In such experiments animals are captured in source habitats, marked and moved to other areas. Thereby it is questionable whether individuals react differently only because they have been displaced or due to other influences like a different landscape structure or habitat type. While several studies investigated the impact of marking on movement behaviour of marked and unmarked individuals, information about the influence of displacement on individual behaviour is lacking. Transferring animals from their home habitat to a foreign area is expected to have a noticeable affect per se on animal behaviour, even if they are transferred between areas of the same habitat type.

In this study, we investigated the influence of translocation of individuals on movement behaviour of the blue-winged grasshopper *Oedipoda caerulescens*. Therefore males and females of *O. caerulescens* were transferred between two areas of the same habitat type and the daily moved distances and turning angles were recorded. From these data directness and net displacement of individuals were calculated. Translocation had a significant effect on female's daily moved distances on the first day (fig. 1). Displaced females moved longer distances than not displaced females (same tendency for males n.s.). Whether individuals were translocated or not had no significant influence on daily turning angles and directness of movement for females and males. In summary, our results clearly pointed out that translocation effects should not be disregarded in future studies.

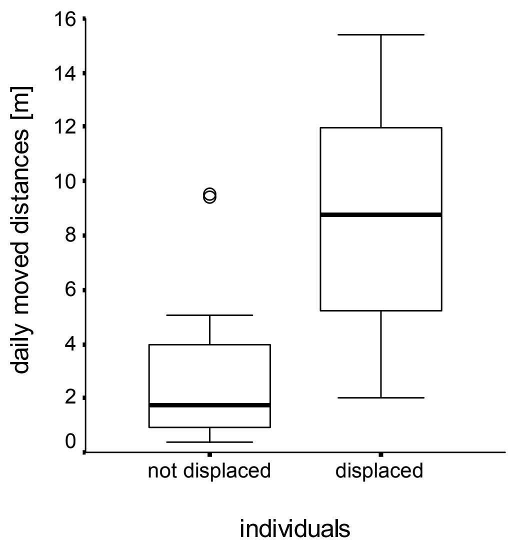

Figure 1: Moved distances of displaced and not displaced females on the first day of recapture.

Dispersing from refugia: expanding populations of the largest passerine

Christian Heuck, Sascha Rösner & Roland Brandl
Philipps University Marburg, Dept. Animal Ecology, Karl-von-Frisch Str. 8, 35032 Marburg, Germany, contact: mail@sascharoesner.de

Due to intensive human persecution, populations of the raven *Corvus corax* declined dramatically in Central Europe in the middle of the 19th century. Around 1940 the raven was nearly extinct in Central Europe except three relict populations which survived in the Alp region, eastern Poland and Schleswig-Holstein/southern Denmark. When persecution stopped, the raven started to recolonize its former range with a velocity of ca 10 km/y. Up to now the former range is not yet completely recolonized. Distribution gaps can still be found west of the Rhine valley in Germany and in France. Although the knowledge about the actual distribution in Central Europe is good, the definite origin of the immigrated birds and the impact of the persecution to the genetic diversity is not known. In our study we used a population genetic approach to detect cryptic genetic variation among the three relict populations. From 2005 to 2007, we sampled ravens from in the newly established populations and tried to assign those birds genetically to one of the three relict populations. Our findings will help to reconstruct the recolonization process of that native passerine.

When we think it's fragmented it may not – *Metrioptera roeseli* in the agricultural landscape

Rebecca Lange (1), Tim Diekötter (1), Stephanie Holzhauer (1), Walter Durka (2) & Volkmar Wolters (1)
(1) Justus-Liebig-University, Department of Animal Ecology, Heinrich-buff-Ring 26-32, 35392 Giessen, Germany
(2)Department of Community Ecology, Helmholtz-Centre for Environmental Research – UFZ, Theodor-Lieser Str. 4, 06120 Halle, Germany

Anthropogenic activities, such as agriculture, frequently lead to repeated changes in the composition and structure of landscapes. The intensive farming regime in the Wetterau in central Germany, for example, has resulted in an isolated distribution of small grassland remnants within an arable matrix. Under a less intensive farming regime in the adjacent Vogelsberg region, however, large and continuous areas of grassland remained. We hypothesised that Metrioptera roeseli, a bush-cricket species preferably occurring in grassland, would show a decrease in genetic diversity and an increase in genetic differentiation among populations along this 34 km covering gradient of grassland fragmentation from intensive to extensive agriculture. The genetic population structure of three populations in each of four decreasingly fragmented agricultural areas was investigated using six microsatellite markers. Contrasting to our expectation, populations of M. roeseli did not differ in genetic diversity either within or among the selected agricultural areas. We suggest that the observed lack of population differentiation even in the fragmented situation may be related to the species` ability to use grassland margins along field tracks for successful dispersal between distant populations. In addition, macropterous individuals – although occurring in low numbers (1% of the population) – may maintain sufficient gene flow for spatially structured populations of M. roeseli to not become genetically isolated. Our results emphasise the need to take into consideration the species-specific movement behaviour when assessing landscape fragmentation in conservation and landscape planning.

Bird-mediated dispersal of freshwater snails

Casper H.A. van Leeuwen (1), Jan van Groenendael (2), Gerard van der Velde (2) &Marcel Klaassen (1)
(1) Netherlands Institute of Ecology (NIOO-KNAW), PO Box 1299, NL-3600 BG Maarssen, The Netherlands
(2) Radboud University Nijmegen, Toernooiveld 1, NL-6525 ED Nijmegen, The Netherlands

Many small aquatic organisms are widely distributed throughout their habitats, and seem to rapidly colonize new suitable areas, which suggests high dispersal capabilities. However, for most aquatic species it is difficult to cross the dry terrestrial terrain between wetlands. So how else can we explain the presence of many aquatic organisms in for example isolated ponds, tens or hundreds of kilometers away from the nearest water?

Passive transport by birds might provide an answer: waterbirds traveling between feeding and roosting sites, or migrating long distances using similar wetlands as stopover sites, could make an ideal transport mechanism for aquatic organisms if they are for example able to survive digestion (internal), or able to adhere to feathers (external). And indeed, there are indications that some aquatic organisms are capable of being transported this way; but due to the low frequency of occurrence direct observations are scarce. Here I provide an overview of my PhD project, which focuses on the potential of waterbirds to disperse small freshwater snails. We combine several approaches to address this question, such as snail survival experiments, species distributions analyses and analyses of genetic variation within and between snail species with contrasting traits.

Detection of migration mechanisms of oribatid mites

Ricarda Lehmitz, Axel Christian & Willi E. R. Xylander
State Museum of Natural History Görlitz, Am Museum 2, 02826 Görlitz, Germany

It is well known that oribatid mites are among the first colonizers of young soils. In contrast, little is known about their immigration pathways. In the present study passive migration by wind as well as active immigration of oribatid mites both above-ground and below-ground is investigated. In field experiments, animal-free substrate from a nearby opencast lignite mine was deposited and animal immigration will be documented over a period of three years (2008 – 2010).

In March 2008 twelve circular plots, 2 m in diameter, were excavated within a meadow and refilled with animal-free substrate. An experimental design with four different treatments was created using a variety of different trap types to answer the following questions:

1. In which order do different oribatid mites arrive in the plots? How far do they immigrate into the animal-free substrate?

First results from mini-pitfall traps with barriers for recording directional movement indicate that epigeic immigration occurs independently from the distance of the surrounding meadow-soil. Several individuals had already arrived 14 days after exposure as seen from mini-pitfall traps. In contrast, no oribatid mites were detected in soil cores.

2. Which species migrate by wind?

The proportions of oribatid mites actively immigrating or being passively transported by wind are determined by taking soil cores from two types of plots: a) one where active and passive immigration is possible and b) one where active immigration is prohibited. Three months after exposure, no oribatid mites were found in both treatments.

To obtain information about how many and which species of oribatid mites are transported by wind we used specially modified sticky traps, that were vertically installed in two heights above the soil surface and showed to be very successful in detecting oribatid mites in the air plankton. Within 14 days after exposure, we collected between one and 28 individuals from a trap surface area of about 0,06 m^2. Direction of wind turned out to be a key factors for the number of individuals trapped.

Seed bank and vegetative growth in gap recolonization: A factorial experiment in Baltic salt grassland

Kristin Ludewig, Antonia Wanner & Kai Jensen
University of Hamburg, Biocenter Klein Flottbek; Ohnhorststr. 18, 22609 Hamburg, Germany

Salt grasslands along the Baltic Coast of Schleswig-Holstein have developed during the last centuries due to traditional grazing regimes. Low salinities and the lack of tidal inundations favour the development of extensive reed beds in the absence of grazing. This kind of successional change became apparent when many sites were abandoned in the 1980`s and typical salt grassland vegetation was replaced by species poor reed belts dominated by *Phragmites australis*. Restoration efforts like the re-introduction of grazing regimes were carried out to suppress the growth of *Phragmites australis* and to re-establish characteristic salt grassland vegetation.

Grazing has many different effects on vegetation. One is the creation of hoof print gaps which can serve as safe sites for germination and establishment of seedlings. We carried out a two-factorial field experiment to analyse the role of seed bank and vegetative growth in the recolonization of vegetation gaps in a salt grassland at the Baltic Coast. 48 vegetation gaps of 20 x 20 cm were prepared in autumn 2006. The soil in the gaps was sieved to remove roots or rhizomes which could reproduce vegetatively. The soil seed bank of the gaps was manipulated by sterilizing half of the soil samples. Vegetative growth from the surrounding vegetation into the gaps was excluded by using nylon mesh. Seedling number in the gaps was counted 5 times during the vegetation period 2007.

636 seedlings belonging to 11 species were counted in the gaps. The most common species recruiting from the seed bank were *Aster tripolium*, *Triglochin maritimum* and *Juncus gerardii*. Mean seedling number was significantly higher in the gaps with recruitment from the seed bank than in plots with seed bank exclusion (ANOVA; $F=57{,}45$; $p<0{,}001$). There was a significant interaction between the factors seed bank and vegetative growth: mean seedling number was highest in the gaps without vegetative growth (ANOVA; $F=5{,}15$; $p<0{,}05$). The number of seedlings declined strongly after six weeks of flooding in July/August 2007 while the number of clonal ramets was continuously rising until the end of the vegetation period.

The seed bank and vegetative growth both made important contributions to the re-colonization of artificial gaps, but vegetative growth was more successful. Seedling density was reduced by vegetative growth most probably due to competition. In this salt grassland at the Baltic Coast of Schleswig-Holstein vegetative growth seems to be more reliable than seedling recruitment out of the soil seed bank, especially under the wet conditions of summer 2007. Small vegetation gaps like hoof prints do not appear to be important safe sites for germination and establishment of seedlings. Other effects of grazing may be more important in facilitating habitats for typical salt grassland species.

Habitat amount versus habitat connectivity: Their effects on biodiversity in traditional Swiss orchards

Susanne Mühlner (1,2), Debra Bailey (2) & Martin Schmidt (3)[3]
(1) University of Leipzig, Germany; (2) Agroscope Reckenholz-Tänikon Research Station ART, Zürich, Switzerland; (3)Institute of Zoology, University of Bern, Switzerland
Corresponding author: susannemuehlner@aol.com

The protection of biological diversity as a main target in recent nature conservation is widespread. Thus, when dealing with issues such as sustaining or increasing biodiversity many different aspects have to be considered.

In this study methods should be defined and improved to explain the diversity of organisms in focal habitats. So, biodiversity and everything that is related to it plays an important role. This includes ecosystem fragmentation which is very important to the structure of landscapes. To detect the impact of habitat fragmentation on species diversity a Cost-Distance analysis can be applied. In recent studies Least-Cost modelling has proved to be a useful approach to identify species movements and dispersal within the landscape matrix using corridors, crossing / avoiding barriers and so on (see [1, 2, 3, 4]). Here, GIS-based Cost-Distance and Least-Cost modelling will be examined to investigate if organism-diversity can be explained in focal orchard habitats in the northern part of Switzerland. As one of the first studies it will deal with functional organism groups instead of only one species in Cost-Distance analysis to cover a wide range of typical orchard inhabiting biodiversity indicators such as spiders, beetles, bugs, snails and birds.

Habitat- and landscape connectivity plays an important role in defining species paths within the landscape matrix. Thus, Least-Cost modelling may provide an approach to explain the diversity of organisms within a focal habitat rather than or in conjunction with other common landscape metrics such as habitat amount and Euclidean Nearest Neighbour. However, using the Cost-Distance approach to get a metric for functional connectivity it should also be tested if landscape connectivity (functional and Euclidean) and habitat amount have different and separate effects on biodiversity as they usually occur together or whether they only have a combined effect on it (see Figure 1).

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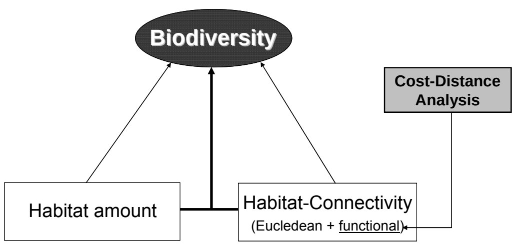


Figure 2: Basic scheme about study content

Floating down the river - urban streams as dispersal corridors for primarily winddispersed invasive tree species

Ina Säumel & Ingo Kowarik
TU Berlin, Section Ecosystem Science / Plant Ecology, Rothenburgstr.12, 12165 Berlin

Human-mediated long-distance dispersal is recognized as a key process in biological invasions. Cities as hotspots of plant diversity may function as sources for the export of nonnative species into surrounding landscapes. Our study addresses the question whether tree plantations along urban rivers may act as initial foci for the water-mediated dispersal of invasive tree species. We released tagged fruits of three primarily wind-dispersed tree species into the river Spree in Berlin, Germany, and studied the subsequent dispersal in the river corridor. Our focal species are highly invasive in Europe (Acer negundo, Ailanthus altissima) or North America (Acer platanoides). Our results demonstrate the effectiveness of seed transport starting from embanked river borders within urban centres over long distances to possibly suitable habitats downstream. Hence, water-mediated dispersal may enable the establishment of these model species in riparian corridors even at great distances from seed sources within urban centres. Furthermore, we discuss consequences for urban landscape architecture and the need to include consequences of secondary dispersal in models on the spread of invasive species.

Identification and sustainable use of ecosystem services

4.1. Across scales: From organismic interactions to biodiversity and ecosystem functioning

Hauke Reuter, Katrin M. Meyer, Fred Jopp, Tamara Münkemüller, Katja Schiffers

Oral presentations

How individual species structure diversity in tropical forests

Andreas Huth (1), Thorsten Wiegand (1), C. V. Salvitri Gunatilleke (2), I. U.A. Nimal Gunatilleke (2)
(1)UFZ Helmholtz Centre for Environmental Research - UFZ, Department of Ecological Modeling, PF 500136, D-04301 Leipzig, Germany
(2)University of Peradeniya, Faculty of Science, Department of Botany, Peradeniya 20400, Sri Lanka

A persistent challenge in ecology is to explain the high diversity of tree species in tropical forests. Although the role of species characteristics' in maintaining tree diversity in tropical forests has been the subject of theory and debate for decades, spatial patterns in local diversity have not been analyzed from the viewpoint of individual species.

To measure scale-dependent local diversity structures around individual species we propose individual species-area relationships (ISAR), a novel spatial statistic which marries common species-area relationships with Ripley's K, to measure the expected α-diversity in circular neighborhoods with variable radius around an arbitrary individual of a target species.

We use ISAR to investigate if and at which spatial scales individual species increase in tropical forests local diversity (accumulators), decrease local diversity (repellers), or behave neutrally. Our analyses of data from Barro Colorado Island (Panama) and Sinharaja (Sri Lanka) reveal that individual species leave identifiable signatures on spatial diversity, but only on small spatial scales. Most species showed neutral behavior outside neighborhoods of 20m. At short scales (< 20m) we observed, depending on the forest type, two strongly different roles of species: diversity repellers dominated at BCI and accumulators at Sinharaja. Nevertheless we find that the two tropical forests lacked any key-species structuring species diversity at larger scales, suggesting that "balanced" species-species interactions may be a characteristic of these species-rich forests. We anticipate our analysis method will be a starting point for more powerful investigations of spatial structures in diversity to promote a better understanding of biodiversity in tropical forests.

Biological interactions determine effects of toxicants on ecosystem level

Matthias Liess, Kaarina Foit, Mikhail Beketov, Ralf Schäfer, Sabine Duquesne
Helmholtz Centre for Environmental Research – UFZ, Permoserstrasse 15, D-04318 Leipzig, Germany.

In streams draining agricultural areas, pesticides affect individuals, populations and community composition. Further impairments of non-target communities by new pesticides needs to be avoided. Hence, there is a great need to realistically extrapolate effects from laboratory single species tests towards communities on the landscape level.

We show that competition between individuals and species, as well as predator prey relationships, need to be considered when predicting effects of toxicants on the ecosystem level. However, when linking multiple levels of biological organization the complex interrelations between individuals, populations and environmental parameters need to be simplified in order to enable mechanistic predictions. We suggest field validated and manageable approaches that support predictions of the ecosystem effects of pesticides.

Body size dependencies of community organisation in transitional waters: theoretical perspectives and field tests

Alberto Basset (1), Gian Carlo Carrada (2), Sotiris Orfanidis (3), Sofia Reizopoulou (4)
(1) University of Salento, Dept. of Biological and Environmental Sciences and Technologies – 73100 Lecce, Italy
(2) University of Naples "Federico II", Dept. of Zoology – 80100 Naples, Italy
(3) National Agricultural Research Foundation, Fisheries Research Institute, 64007 N. Peramos, Kavala, Greece
(4) Hellenic Centre for Marine Research, Institute of Oceanography, Anavyssos, Greece

Community patterns description is recognized as a necessary step toward the understanding of ecosystem complexity, structure and functioning. Patterns contain "coded" information on internal organisation of a system, which can be decoded through mechanistic approaches that allow inferences and predictions both on the ecological status of the system and its expected changes. In transitional waters, the abiotic environment forcing factors are likely to filter species according to functional traits more than to some traits taxonomic dependent. Body size is the most integrative individual trait and it is a 'taxon free' attribute of species with extensive implications at different levels of the hierarchical ecological organization. Coherent variations of body size of organisms with energy, space and time constitute some of the most consistent macro-ecological patterns. The idea that biological rates and times are ultimately limited by the body size-related rates at which energy and materials are acquired and distributed, has been largely utilised to develop a mechanistic metabolic theory that explain these observed patterns. By integrating ecological stoichiometry and energetic with distribution network and competitive coexistence hypothesis, metabolic theory also predicts body size patterns at the level of single population, guild, trophic level, community, ecosystem and landscape. Here, we address evaluation of ecosystem health in transitional waters on the ground of both theory driven and data oriented evaluation of macroecological patterns of community structure components. This comparison, is aimed at searching for the most proper scale dependency factor of community structure patterns as well as at searching for scale invariant components. To this aim, data from three different guilds, i.e., phytoplankton, phytobenthos and macro-zoobenthos, characterised by different rates of both metabolism and life cycles, are analysed. Null and neutral model approaches are used to distinguish stochastic and shape properties from deterministic filtering. The ecological relevance of theory driven approaches to decode the macroecological patterns into mechanisms applicable by stakeholders to manage transitional ecosystem in the framework of socio-ecological sustainability will be discussed.

Classification of transitional water health from descriptors of macro-invertebrate size structure

Nicola Galuppo, Letizia Sabetta & Alberto Basset
University of Salento, Dept. of Biological and Environmental Sciences and Technologies, 73100 Lecce, ITALY

Taxonomically and non-taxonomically based approaches can be used to classify the biological variability of communities and to derive mechanistic explanation of macro-ecological patterns. Many taxonomic-based indicators have already been proposed to assess changes in transitional water communities; however, attention has to be used on their applications and implications that could lead to taxonomic classification difficulties, improper use of multi site comparisons and ambiguous behaviors, along disturbance and/or stress gradients. Alternatively, the authors propose methods based on body size patterns observed at guild and community levels. These methods offer the opportunity to compare sites with different taxonomic compositions and allow development of indicators related to the ecological status of the communities under observation. The eligibility of these taxonomic free descriptors to provide relevant information is discussed for benthic macro-invertebrates. A database has been built from 16 transitional water ecosystems in the geographic area comprised between the Eastern coast of Italy and the Black Sea coasts of Romania in order to inter-calibrate descriptors of the ecosystem ecological status. The considered ecosystems were selected according to their quantitative and qualitative exposure to pressures, including chemical pollution, salt production, eutrophication and confinement. Data collection was synoptic at two seasons, late spring and early fall. Pressures were quantified as external potential pressures from land-use data and as internal pressures from collection of physical and chemical data of both water column and sediments and of physiographic and hydrological data. At least four stations were sampled per ecosystem and at least two at every habitat type and stress level on the pressure gradients. Responses were quantified from analysis of body size abundance distributions of benthic invertebrates which were quantified at every study site and sampling times using 5 replicate samples. Results showed that physiographical and physical features of transitional waters, spatial and temporal heterogeneity are relevant sources of variation of descriptors of macro-invertebrate size spectra. When size spectra are detrended according to these factors, most of the residual variability of size spectra descriptors is accounted for by external stress gradients. Along these gradients, size structure features were observed to be better descriptors than taxonomically-based tools and multi-metric indices. From the body size descriptors, we derived a rapid bio-assessment method, based on the largest size classes of benthic invertebrates, which is simple, measurable, affordable, rapid and time limited.

Climate change threatens snowbed species at the community level

Christian Schöb (1), Peter M. Kammer (2), Zaal Kikvidze (3), Philippe Choler (4), and Heinz Veit (1)*
(1) University of Bern, Institute of Geography, Hallerstrasse 12, 3012 Bern, Switzerland
(2) University of Teacher Education, Biology Department, Gertrud-Wokerstr. 5, 3012 Bern, Switzerland
(3) University of Tokyo, #568 Environmental Bldg., 5-1-5 Kashiwanoha, Kashiwa, Chiba 277-8653, Japan
(4) University J. Fourier Grenoble / Laboratoire d'Ecologie Alpine, 38041 Grenoble, France
**Corresponding author: christian.schoeb@phbern.ch*

Alpine snowbeds hold many characteristic species specialised to this extreme habitat, were the growing season depends particularly on snowmelt date. With climate change growing season length will be extended due to earlier snowmelt in spring. The future vegetation composition will depend on the availability of invading species from neighbour plant communities and the plant-plant interactions that predominate in snowbeds. Non-random spatial patterns in plant communities can reveal the type of predominant interactions in snowbed communities. Spatial association (aggregation) of specialised and invasive species may indicate to facilitation and coexistence. Conversely, if specialised and invasive species show spatial disassociation (segregation), then the probable outcome of invasion will be competitive exclusion.

In the Swiss Alps we studied spatial patterns of snowbed communities along a snowmelt gradient using variance ratio of species richness in small circles. The major finding was that specialised snowbed species were generally spatially aggregated with each other, but were segregated from invasive grassland species, particularly in the earlier melting sites. Additionally, the number of significant associations/disassociations out of all possible pair-wise co-occurrences clearly decreased with later snowmelt dates. But, the percentage of pair-wise associations decreased only to one fourth whereas pair-wise disassociations dropped by half.

The spatial patterns across the whole snowmelt gradient confirmed the categorisation of snowbed species according to their distribution pattern along the gradient established in a previous study. Thus, they partially reflected the inherent environmental heterogeneity caused by the snowmelt gradient. Within single snowmelt dates, most probably competition between grassland species and snowbed species led to their segregation. And this competition-based segregation increased with earlier snowmelt indicating an increased importance of competition in snowbeds with climate change. We assume that grassland species in snowbeds currently are restricted to the earlier melting sites due to their intolerance of the prevailing conditions in late-melting sites. Conversely, the snowbed species are pushed back to the later melting sites due to competitive exclusion by grassland species under milder growing conditions.

As a result of climate warming, the snowbed species will lose their habitat within which they are competitive, and invading grassland species will replace them. Consequently, even if the species richness in snowbeds will increase by invasions of grassland species due to climate change, the regional diversity will decrease by local extinction of snowbed species. Thus, this study shows the importance of plant-plant interactions for changes in plant community composition due to climate change and highlights the high sensitivity of alpine vegetation.

Colour matching is not equivalent to crypsis in crab spiders

R. Brechbühl (1), J. Casas (2) & S. Bacher (1)
(1) University of Fribourg, Chemin du muse 10, 1700 Fribourg, Switzerland
(2) University of Tours, IRBI UMR CNRS 6035, 37200 Tours, France

The ambush predator *Misumena vatia* varies its body colour between white and bright yellow thereby matching the colour of the flower it sits upon. This phenomenon is thought to avoid their detection by potential prey (pollinators), a phenomenon called crypsis. Such cryptic spiders are thus expected to have more encounters with pollinators resulting in a higher foraging success. We tested if the visitation frequency of pollinators to flowers harbouring a crab spider is higher when colours of spider and flower match. Yellow or white spiders were placed on yellow, white and violet flowers in a complete factorial design, resulting in six different colour combinations of crab spiders and flowers differing in their degree of colour matching. In contrast to our expectations, we found that pollinators generally avoided flowers harbouring spiders, independent of the degree of colour matching. Thus, crypsis cannot explain the observed colour matching behaviour of crab spiders.

Ecological boundary detection in point patterns

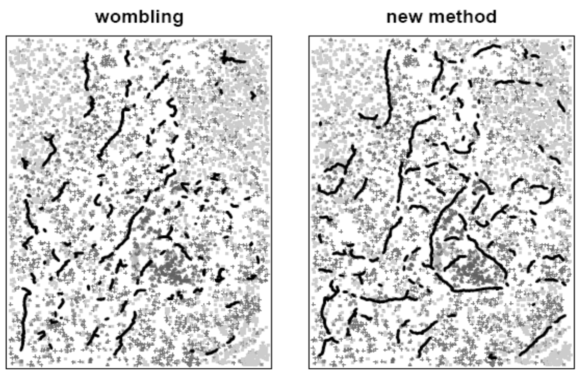
José M. Blanco-Moreno (1) & Mark R.T. Dale (2)
(1) University of Barcelona, Department of Plant Biology, Av. Diagonal 645, 08028 Barcelona, Spain
(2) University of Alberta, Department of Biological Sciences, T6G 2E9, Edmonton, AB, Canada

Boundary analysis is a fundamental step to define limits between populations and communities, and it constitutes a first step into the analysis of spatial and temporal changes of their distribution and its relation to other organisms' distribution [1]. However very little has been done for the detection of boundaries in point patterns, especially in multivariate point patterns (i.e. marked events with spatial coordinates: e.g. mixed forests, burrows of different species, outbreaks caused by different microbial strains...) Many methods exist to delineate patches and boundaries in georeferenced sample data [1], but the study of boundaries in point patterns has been limited by the lack of specific methods. We propose an adaptation of an edge detection method for image processing [2] for the analysis of boundaries in point patterns, and show its performance in a mixed forest dataset.

Boundaries in a planar marked point pattern can be defined as those lines that display the most dissimilar neighbourhood composition on either side. We can define a local neighbourhood through kernel density estimation. For each point we compute a pair of multivariate density estimates ($g+$ and $g-$) by means of a kernel function in separate domains: the "positive" side of the kernel and the "negative" side. Then, an appropriate dissimilarity measure δ between $g+$ and $g-$ [3] is computed at various orientations to find the angle θ that yields the highest dissimilarity δ [2]. These operations produce a "dissimilarity surface", but we must focus only the ridges where the dissimilarity is at a maximum. These can be found by taking directional derivatives of the "dissimilarity surface". Selection of the ridges can then be performed on a threshold basis [1]. The most extreme are "boundary elements" and are candidates to be part of longer boundaries in the data. These boundaries can be tested through a randomisation test using boundary statistics [4].

Our method compares favourably with other approaches to boundary analysis in point patterns based on interpolation (v.g. wombling [1], see Figure 1). It is able of a detailed characterisation of the patterns, and is not as dependent on the selected threshold. It offers a very promising starting point for further research.

Figure 1: Boundary analysis of a multivariate point pattern (mixed forest with 9 species) by means of wombling and of our new method. Different symbols and shades of gray are used for different species. Black lines indicate the detected boundaries. Patches are more clearly delimited with our method.



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Survival of the fattest? Contradictory results in interaction experiments due to different response variables

Katja Schiffers (1), Katja Tielbörger (2) & Florian Jeltsch (1)
(1) University of Potsdam, Plant Ecology and Nature Conservation, Maulbeerallee 2, 14469 Potsdam, Germany
(2) University of Tübingen, Plant Ecology, Auf der Morgenstelle 3, 72076 Tübingen, Germany

Studies assessing the intensity and direction (positive vs negative) of interactions among plants often lead to controversial results despite comparable experimental designs. Besides several ecological explanations relating to differences in environmental conditions, also methodological reasons have been discussed. It has been found that measuring survival as a response of plant-plant interactions relatively often indicates facilitation whereas using growth rates or biomass more often indicates competitive effects under the same conditions.

In this study, we state that this effect is not a purely mathematical issue of binary vs. continuous response variables as usually assumed, but indeed an outcome of underlying ecological processes. Our hypothesis is a combination of the Bertness/Callaway model [1] relating interactions to the stress level of the environment and the pulse/inter-pulse approach of Goldberg and Novoplansky [2]:

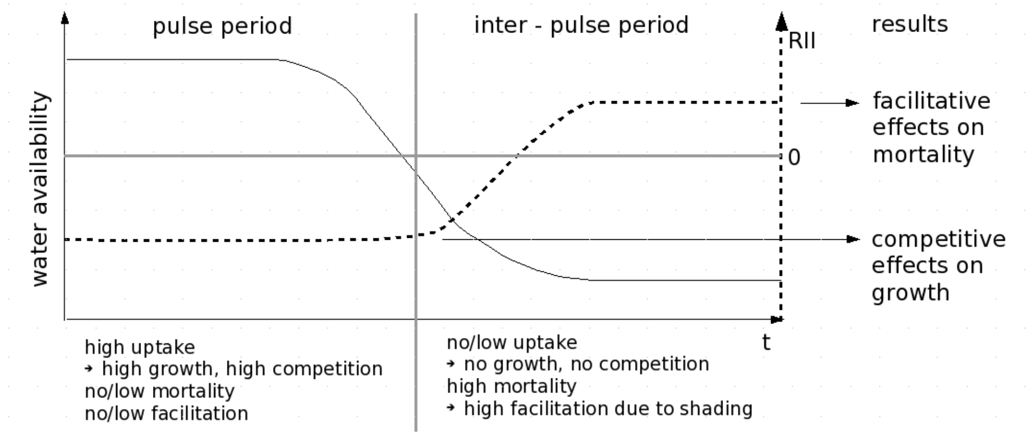

Figure 1: Hypothesised effect of pulse/inter-pulse dynamics on survival and growth

We will show results of a greenhouse experiment (to be conducted in summer 2008) designed to test this hypothesis and discuss the results in the light of future experimental approaches.

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Measuring plant competition and predicting community dynamics

Christian Damgaard
University of Aarhus, Department of Terrestrial Ecology, NERI, Vejlsøvej 25, 8600 Silkeborg, Denmark

Plant – plant interactions are an important part of the mechanism by which environmental change drivers affect plant species and communities, and if we know how external factors such as nitrogen deposition or a changing climate affect the competitive relationships in plant communities, then the effect of the external factors on plant community dynamics may be predicted. However, for most natural ecosystems the key plant species are perennials and it is difficult to conduct manipulated competition experiments that are relevant for making ecological predictions. Here, a method for measuring plant competition non-destructively in nature and making ecological predictions using permanent plots is demonstrated and exemplified by investigated case studies.

Interspecific competition in shallow lakes; how a bottom dweller beats the canopy

Bert Hidding
NIOO-KNAW, centre for limnology, Nieuwersluis, The Netherlands

The aquatic macrophyte vegetation in the shallow Lake Veluwemeer shifted in dominance from mainly fennel pondweed (*Potamogeton pectinatus*), which has a floating canopy, to the bottom dwelling stoneworts (*Chara* spp.) in the 1990's. The improved light climate after decreased nutrient loading in the lake probably facilitated initial colonization by *Chara*. The consecutive shift in dominance has been explained in terms of competition for dissolved inorganic carbon [DIC] with *Chara* being the superior competitor for this possibly limiting resource. Since both species are unable to take up inorganic carbon from the sediment, *Chara* should have a negative effect on *P. pectinatus* even when the latter has its own supply of sediment nutrients. In a replacement series in mesocosms we tested the effect of different initial densities of *Chara* cultured in pots on growth of *P. pectinatus* (in pots). Initially, higher densities of *Chara* indeed coincided with both lower levels of [DIC] and stunted growth of *P. pectinatus*. However, in the longer run, the effect of *Chara* on *P. pectinatus* disappeared. We suggest that as soon as a substantial number of *P. pectinatus* leaves reach the water surface, atmospheric carbon becomes increasingly available for photosynthesis. Although competition for carbon may contribute to the shift from *P. pectinatus* to *Chara*, we suspect the involvement of additional mechanisms, most notably herbivory.

Competitive interactions in aquatic communities can regulate mosquito larvae populations

Sabine Duquesne (1), Iris Kroeger (2) and Matthias Liess (2)
(1) Helmholtz Centre for Environmental Research – UFZ, Department of Biology Conservation, Permoserstrasse 15, D-04318 Leipzig, Germany
(2) Helmholtz Centre for Environmental Research – UFZ Department of System Ecotoxicology, Permoserstrasse 15, D-04318 Leipzig, Germany

Invasive species, pests and disease vectors are believed to regain ground in temperate areas due to changes of global climatic conditions and associated changes of weather patterns (floods etc). For example, the occurrence and spread of the mosquito *Aedes albopictus* in Italy since 1990 has implications for its recent introduction into other parts of Europe and related risks. The 2007 outbreaks of Chikungunya Fever in North-East Italy and of blue-tongue disease in Germany as well as the number of West Nile virus cases reported recently in USA and Europe demonstrate the increasing risk due to arboviruses.

Therefore the ecological knowledge about mosquito larvae and associated aquatic communities is needed to understand and predict the population and community dynamics. Both experimental and field approaches have shown that the establishment and development of mosquito larvae populations *Culex pipiens pipiens* are strongly reduced in presence of food competitors. Oviposition habitat selection can be largely influenced by the extent and nature of competition with the associated zooplankton communities. Indeed, densities and species richness of communities affect gravid mosquitoes selecting in priority habitats with low risk of inter and intra-specific competition for their offspring.

Our findings demonstrate that interactions between individuals and species have strong implications on population and community dynamics. They need to be considered when planning ecosystem management measures.

Asymmetric interactions in plant-mutualistic networks: structure and function

Zsófia Benedek (1), Katalin Gallasy (1) & Ferenc Jordán (2)
(1) Eötvös Loránd University, Pázmány Péter stg 1/C, H-1117, Budapest, Hungary
(2) Hungarian Academy of Sciences and Hungarian Natural History Museum, Animal Ecology Research Group, Budapest, Hungary

Mutualistic interactions between plants and their pollinators or seed-dispersers play a major role in the life of natural communities alike in agricultural ecosystems. This role, which ranges from plant reproduction to ecosystem services, calls for scientific and also economic inquiry. Many authors regard mutualistic communities as coevolved structures, and interactions between plants and animals seem to be highly asymmetric: plants depend stronger on animals than vice versa.

One can represent communities with networks; nodes are species, links are interactions between them. Mutualistic networks are characterized as bipartite graphs which mean that there are two different subsets of species (plants and their partners) and interactions are only between the elements of different subsets.

We used an international database to estimate possible topological constraints on asymmetry of interactions by application of *TI*, "Topological Importance" index. We compared topology-based asymmetry to empirical asymmetry values derived from field works. In many cases this estimation proved to be considerably fair, which implies that the structure of a community strongly determine the interaction thereby function of species. Our results suggest that plant-pollinator and plant-seed-disperser interactions behave the same way in conjunction with other earlier works.

These results can be important in better understanding of functioning of these special communities, and additionally can facilitate the planning of further field experiments.

Alternation of functionally different species damps community variability in a predator-prey system

Katrin Tirok & Ursula Gaedke
University of Potsdam, Department of Ecology and Ecosystem-Modelling, Maulbeerallee 2, 14469 Potsdam, Germany.
tirok@uni-potsdam.de

Classical predator-prey models consistently predict pronounced predator-prey cycles or equilibria with either the predator or the prey dominating or suppressed. In contrast, we observed a remarkable coexistence of predator (algivorous ciliates) and prey (small phytoplankton) both at relatively high biomasses over 15-30 generations in a large deep lake which could not be reproduced by a 1-predator-1-prey model. In contrast, a multi-species predator-prey model captured the observed predator-prey dynamics when predator species differed in their food-selectivity and prey species in their edibility. Food-selectivity and edibility were related to other properties (half-saturation constant, maximum growth rate, capacity) resulting in ecological trade-offs. For example, the prey species with the highest edibility also had the highest maximum growth rate. Data and model revealed endogenous driven alternations of the different species yielding a higher variability in species-specific biomasses than in total predator and prey biomass. This holds for a broad parameter space as long as the species differ functionally.

Do above- and belowground herbivores have differential effects on plants? A meta-analysis

Sebastian Heinisch, Roland Brandl and Martin Schädler
Philipps-Universität Marburg, Faculty of Biology, Department of Animal Ecology, Karl von Frisch Straße 8, 35041 Marburg, Germany

Herbivores can have strong deleterious effects on plant growth, reproduction and survival. Moreover, there is ample evidence which demonstrates the important role that insect herbivores have in influencing plant community composition by affecting performance of plant species differentially. Only few studies allow a direct comparison of the effect of aboveground insect herbivores with those of belowground insect herbivores [1,2]. By all means, these studies suggest that above- and belowground herbivores may have different effects on the structure and dynamics of plant communities which is assumed to be due to specific effects of above- and belowground herbivory on annual or perennial plant species.

We used a meta-analysis to review the results of published studies that examine the relationship between insect herbivory and plant performance. We compare if common concepts concerning specific effects of insect herbivores explain a significant proportion of the variability of herbivore effects. For this we evaluate if (i) above- and belowground herbivores influence herbaceous plants differentially, (ii) the effects of above- and belowground insect herbivores differ when feeding on perennial or annual plant species, (iii) there are any differences in the effects of the feeding-mode of insect herbivores and (iv) generalist and specialist insect species have different effects on perennial and annual plant species. All investigated traits of plant growth and reproduction were significantly negative affected by both above- and belowground herbivory of insects. However, we found no general differences in the impact of above- or belowground herbivory, herbivore feeding mode as well as generalist and specialist insects on different plant life-history groupings. At least the larger databases for perennial plants provide strong evidence for no differential effects of above- and belowground herbivory across studies. It is concluded that any effects of these categorizations may be masked by the variability caused by specific experimental and environmental conditions across studies. Differential effects of above- and belowground herbivory in field studies may further be explained with the different temporal and spatial dynamics of these groups in natural ecosystems. In addition effects of insect herbivores on different life-history groupings in terms of total abundance or biomass often occur due to the responses of the actually dominant plant species and may not be consistent across species within these groups [2]. However, our ability to evaluate these patterns is limited by the small number of studies, especially those concerning belowground insect herbivores, gall-building, stem-boring, xylem and phloem sap-feeding insects.

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Plant-soil feedback interactions of Ragwort along a chronosequence of ex-arable fields

T.F.J. van de Voorde (1,2), W.H. van der Putten (1,2) and T.M. Bezemer (1,2)
(1) Netherlands Institute of Ecology (NIOO-KNAW), Centre for Terrestrial Ecology, Department of Multitrophic interactions, Boterhoeksestraat 48, Heteren, the Netherlands
(2) Wageningen University and Research Centre, Laboratory of Nematology, Binnenhaven 5, Wageningen, the Netherlands

Ragwort (*Jacobaea vulgaris*, previous nomenclature *Senecio Jacobaea*), is an early successional plant species whose abundance typically increases during the first years of secondary succession, but this increase is followed by a rapid decline. We hypothesized that this decline is caused by interactions of the plant with soil organisms and with the neighboring plant community. To test this hypothesis we conducted vegetation surveys at a chronosequence of ex-arable fields at a central situated sandy area, the Veluwe, in the Netherlands. The age of these fields ranged from two to 25 years old. In each field we recorded the abundance and size of ragwort plants, recorded which plants surrounded individual ragwort plants, and determined the composition of the soil community underneath the plants. In a greenhouse study we determined plant-soil feedback responses, by growing ragwort, for two growth phases, in sterile soil inoculated with field soil originating from the chronosequence fields. We will show temporal changes in ragwort abundance in the field, and how this is related to plant community dynamics, and to interactions of the plant with the soil community.

Genotypic variability of herbivory, leaf traits and decomposition in poplar

Martin Schädler, Lena Kempener, Nora Künkler, Christine Tölle-Nolting & Roland Brandl
University of Marburg Department Animal Ecology, Karl-vonFrisch-Str. 8, 35032 Marburg, Germany

Plant genotypes may differ in the quality of the produced leaf material consequently in their effects on the associated consumer communities. In this study we test the hypothesis that differences in leaf and litter quality between genotypes of the *Populus deltoids x nigra*-hybrid complex may have influences on herbivore attack, leaf palatability and decomposition dynamics. Using a clone collection in a common garden, we assessed leaf traits, herbivore attack in the field, palatability to generalist and specialist herbivores in the lab and *in situ*-decomposition rates of litter.

All investigated traits showed considerable variability between genotypes. Feeding damage in the field and palatability trials suggest different effects of genotypic variability on herbivory by generalist and specialist insect herbivores. This difference is further reflected in the relationships between chemical leaf traits and feeding rates. Different decomposition rates suggest *'after life'*-effects of intraspecific variability on ecosystem functions, e.g. soil fertility. The genetic identity of plant individuals should therefore have important consequences for the performance and abundance of associated consumers and ecosystem productivity.

Effects of the landscape matrix on biodiversity and invasions in natural areas

Maciej Biernacki
University of Memphis, Department of Biology, Memphis, TN 38152, U.S.A

Models of landscape and metapopulation ecology assume a binary landscape, composed of 'habitat' directly used by biota and empty 'matrix'. Most research has been focused almost exclusively upon the habitat patch ocupied by biota ignoring the surrounding matrix quality and quantity.

Present study investigated effects of land-use in the background matrix of land surrounding a series of 89 natural areas (NA) in the Niagara Escarpment World Biosphere Reserve, Ontario, Canada. Seven land-use categories, corresponding to core, buffer, and transition areas, were mapped in the areas surrounding designated NAs and quantified using Geographic Information System procedures. The biodiversity information collected from published data for these NAs. Stepwise logistic regression was used to identify factors significantly affecting presence/absence of particular biotic groups at a NA, and stepwise parametric regression for factors affecting the number of species in each biotic group.

Study results indicate differences in land-use among NAs. Type and proportion of land-use at different contour-distances from the edge of each NA had significant effects on likelihood of plant invasions and local and regional species richness. Results of logistic analyses indicated that the likelihood of presence of major biotic groups was enhanced most by increased surface area of the NA, followed in the land-use category, by increased proportions of surrounding land occupied by neighboring patches of other NAs and buffer areas. The likelihoods of finding species among the plants, birds, herptiles and mammals recorded for the region were decreased by greater proportions of surrounding land-use categorized for mineral resource extraction and for minor urban centers. Results demonstrate that land-use in the surrounding matrix may play an important role in long-term protection of native biota, particularly in groups of rare and endangered species. For all globally-rare biota except butterflies, surface area of NA had greater effects on rare-species richness than effects of matrix. Richness of regionally-rare birds was more affected by plant community diversity than by surface area of NA. Number of recorded plant communities accounted from 2.1% of variation in number of globally-rare plant species and as high as 31% of variation in regionally-rare butterflies. The diversity of plant communities was itself influenced by total site area (accounting for 45% of variation), extent of elongation of the NA, and both external- and interior- edge perimeters. For example, provincially rare birds had a 50% likelihood of occurring on NAs with surface area > 6.1 ha and this likelihood increased to 95% on NAs with surface area > 397 ha and with surrounding proportion of Escarpment Rural Areas > 31%. The number of species in each biotic group was significantly affected by land-use at different distances from the edge of a NA depending on group.

Results of present study indicate that conservation management should always be focused on multiple species and diverse groups of biota and inclusively consider quality and quantity of landscape matrix.

How dispersal limitation, local recruitment limitation, fire, and grazing affect savanna structure and dynamics

Justin M. Calabrese & Volker Grimm
Helmholtz Centre for Environmental Research-UFZ, Dept. of Ecological Modelling, Permoserstrasse 15, 04318 Leipzig

Savanna ecosystems are widespread, ecologically and economically important, and despite considerable research effort, still not well understood. Research on savannas has focused intensively on elucidating the factors that affect tree-grass coexistence, tree spatial patterning, and bush encroachment. Among the processes so identified are tree dispersal limitation, tree recruitment limitation, fire, and grazing. Models have been used extensively to help understand savanna dynamics, but have tended to be either spatially implicit analytical models focusing on one or two factors, or spatially explicit simulation models including these key ingredients among many others. Though these efforts have improved our understanding of savannas, no consensus on the relative importance of and interactions among the key processes has yet emerged. We argue that this lack of progress is partly due to savanna models being either too simple and neglecting key interactions or too complex and burying these interactions among many other less important ones. Here, we describe a cellular-automata-based approach that is spatially explicit, incorporates simplified descriptions of the above-mentioned key processes, and is tractable by equation-based analytical techniques. We then derive mean-field and pair approximations of the full model and use these approximations to help understand the qualitative behavior of the model and identify which processes and interactions are most important. We demonstrate that trees and grasses coexist over a wide range of conditions, and that a moderately negative effect of nearby established trees on tree seedling recruitment success (hereafter local recruitment limitation) is sufficient to keep tree abundance relatively low. The spatial structure of the tree population is determined by the relative spatial scales and strengths of local recruitment limitation and dispersal limitation. Fire has only limited potential to control tree population size when acting alone, but can strongly suppress tree population growth when coupled with a small degree of local recruitment limitation. Under these conditions, intensive grazing can dramatically alter the tree-grass balance and lead to bush encroachment. We conclude by comparing our combined results to those obtained separately from a range of other modeling approaches.

Insights from a diversity-functioning simulation model

Tanja Reinhold, Hans Dähring& Christian Wirth
Max-Planck-Institute for Biogeochemistry, Department Organismic Biogeochemistry Jena, Germany

Experiments clearly show that ecosystem functioning in grasslands is positively affected by species and functional group richness. Complementary resource use and the selection effect have been proposed as possible mechanisms underlying this response. Additive partitioning analysis applied to the data of the Jena Experiment revealed that both mechanisms operate and that the relative importance of the complementarity effect increases over time. However, how the two mechanisms actually operate and how they affect different ecosystem functions remains largely unknown.

We are using an ecophysiological, individual-based grassland model (GEMINI [1]) to identify the processes underlying complementarity and selection effect. We are doing this by copying a diversity experiment to our model using pseudo-species (Table 1). The parameters of these pseudo-species are estimated from a manifold in trait space defined by the species pool of the Jena Experiment (Figure 1). This approach allows us to explore how different processes (productivity, light capture, nutrient uptake, carbon sequestration, etc.) are affected by the magnitude and quality of functional diversity.

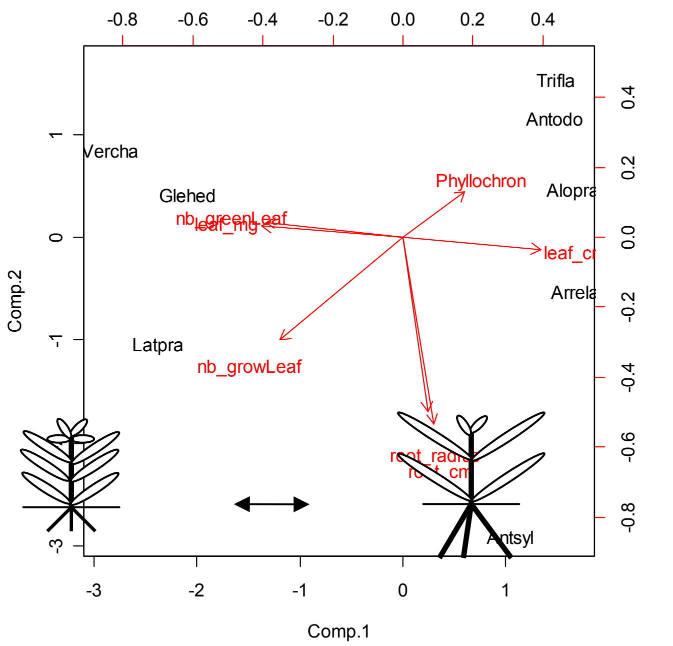

Figure 1: *Principle components analysis for a set of traits of some grasses, herbs and legumes. Parameters for the pseudo-species estimated along* the first principle axis of this analysis.

Table 1: Experimental design of the diversity-functioning simulation. We created 4 pseudo species for each of our functional groups. Orthogonality of species and functional diversity was maximized.

Functional group richness				
4				12
3			12	9
2		12	9	6
1	20	9	6	6
	1	2	3	4
	Species richness			

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The effect of ecological memory on biodiversity in disturbed ecological systems

Richard Zinck & Volker Grimm
Helmholtz Zentrum für Umweltforschung -UFZ, Department Ökologische Systemanalyse, Permoser Str.15, 04301 Leipzig, Germany

The interaction between disturbance and recovery is a major determinant of many ecosystems' spatio-temporal dynamics and function. Empirical studies of several disturbed ecosystems have led to the hypothesis that ecosystems develop maximum diversity at intermediate disturbance levels [1]. Simulation models are widely used for exploring the mechanisms which underly these observations.

The disturbance intensity depends on local conditions to a varying degree [2]. On the one hand, ice bergs 'scratch' the sea floor regardless of what benthic community is present. Wildfire, on the other hand, depends to a larger degree on the type and state of vegetation it encounters in its spread. This local state is determined, in turn, by the time since the last fire which initiated secondary succession. We refer to this local dependency of susceptibility on the time since the last disturbance as ecological memory.

While the hump-shaped relationship between diversity and disturbance intensity is well studied, the consequences of varying degrees of ecological memory in ecosystem response to disturbance are still not well known [3]. We use several cellular automata models from the literature developed for benthic and wildfire systems to study the effect of a varying degree of ecological memory on the diversity – recovery relationship.

Our results show that the disturbance-recovery curve is indeed influenced by the degree of ecological memory in the system. As ecological memory increases, the curve becomes steeper while the maximal diversity attained is lower. Bimodality, if present, is fostered. We discuss these effects using succession models developed for actual forests in North America and Tasmania. Further understanding is gained by the use of a flow equation to describe the two extreme cases of no versus strong ecological memory.

A better, more mechanistic understanding of the role of ecological memory on biodiversity in disturbed ecosystems will provide further levers for coping with the effects of the changing climate.

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Can cellular automata models incorporate cross scale variability? A case study

Yiannis G. Matsinos
University of Aegean, Department of Environment; Xenia Building, University Hill, 81100 Mytilini, Greece

In our effort to model interacting biological systems we tend to use modelling methods with simple principal rules able to reproduce realized and sometimes complicated patterns. Our knowledge of the details of a particular mechanism is often full of gaps and, unlike mathematics there are only a few ecological “laws” such as the Navier–Stokes equations or Newton’s laws. The speed by which calculations can be made allows the investigator to examine a huge number of parameter ranges that would be otherwise impractical for more “realistic”. In particular it can be employed in the ecological context to represent heterogeneous and dynamic habitat structures. In short, the Cellular Automaton consists of discrete simulations in time, space and in the system state. The idea of these models consists in considering each position (or region) of the spatial domain as being a cell which is attributed to a state. The state of each cell is modified regarding both its own state and its neighbor’s during the former time stage, through a series of simple rules that try to mimic the physical or biological laws, which are, in our case, the ones that rule the system. In this approach, the system state variables, as well as the time, are discrete. There is an ongoing interest for the mechanisms responsible for the observed patterns of species composition within plant communities. A number of earlier studies on plant competition indicate that resource competition and interspecific differences in seed dispersal may indeed be important factors shaping population dynamics in plant communities. Most theoretical work has been focused on either competition for light or nutrients or, on the other hand, seed dispersal using in most of the cases probabilistic approaches. Both processes are characterized by a pronounced spatial dimension, so in order to be investigated one has to use spatial models. In our study we tried to integrate the two processes, using cellular automata models that takes into account both species dispersal and competition characteristics in an effort to understand how natural patterns of plant distributions arise. Our aim was to quantify effects of competition and dispersal in grassland community dynamics, particularly the effect on resilience of the communities to gap creating disturbances that were imposed at different spatial extent. We wanted to test the hypothesis of scale dependent-dominance by looking at competition outcomes of varying grid size using the same basic hierarchy rules. In our simulations we used data from an experimental biological community assembled with five grassland species. Model results showed that longer dispersing plants may have a competitive advantage in their colonization success as compared to the better competitors, especially in the cases of a disturbance-mediated creation of gaps in the landscape. An increase in our mesh size resulted in a decrease of species dominance and thus to more resilient end communities and a higher percent cover of the landscape.

Development of a Knowledge-Based Tool for Biodiversity Assessment as a Basis for Coastal Dune Conservation and Management

Yehonathan Rubinstein, Tal Svoray & Pua Bar(Kutiel)
Ben-Gurion University of the Negev, Department of Geography and Environmental Development, Beer-Sheva, 84105, Israel

During the last decades, sand dunes - mainly mobile and semi-stabilized - have become a rare component in Israel's Mediterranean coastal landscape due to intensive urban and infrastructure development. The only large sand dune area that remains minimally undisturbed is the Nizzanim nature reserve (20 square km^2). The area consists of coastal sand dunes in various stabilization levels. In the absence of an active management policy, a stabilization process of active and semi-stabilized dunes occurs. As a result of this ongoing process there is a decrease in biodiversity of the landscape, a major change in the composition of plant and animal communities and the disappearance of rare, endemic and psammophile (mobile sand living) species.

The various sand dune types are characterized by different plant and animal communities, as well as different indicator species. Prior researches have classified dune types by either their mobility level (mobile, semi-stabilized and stabilized) or their perennial plant coverage. These two types of classifications are general and adequate mainly to the end cases (namely the active and stabilized dunes). Moreover, the variety of stabilization stages between the ends cases observed in the field have all been included under the term semi-stabilized dunes. This wide range of dunes consists of dunes with diverse floral and faunal communities and therefore it highlights the need for a detailed high-resolution classification for management purposes.

In this study we aim to (a) understand the biodiversity pattern of the Nizzanim nature reserve in the landscape scale; (b) build a statistical GIS model for the estimation of landscape-scale biodiversity in areas with limited data; (c) improve the resolution of landscape unit classification by use of recent high resolution aerial photos combined with biotic and a-biotic features; (d) produce a spatial map of the biodiversity of the Nizzanim nature reserve, focusing on areas that are of higher priority for management.

Many researches use species richness as a substitute of biodiversity, as it is an important indicator which is measured easily. As the use of species richness as a sole substitute for biodiversity is ecologically limiting, this research uses a combination of indices representing the species richness, abundance and the species affinity to mobile dunes. This research deals with various aspects of biodiversity, dealing with species, communities and physical landscape units.

A GIS database was established supported by empiric data that was collected in the field which included perennial coverage, plant and arthropods richness and abundance, species affinity to mobile sand dunes (mobile sandiness index) and approximation of the dunes to adjacent land uses. The database was used to develop a generalized linear model (GLM). The output of the model is an equation describing the relationship between perennial plant cover, spatial variables and biodiversity indicators. The model was validated using field data observed from randomly chosen dunes.

Preliminary results show that the factors that most determine the dune biodiversity are the perennial plant cover, dune area and the distance from adjacent urban areas.

Individual-based models of communities and ecosystems: dream, nightmare, or reality?

Volker Grimm
Helmholtz Centre for Environmental Research – UFZ, Department of Ecological Modelling, Permoserstr. 15, 04318 Leipzig,Germany, e-mail: volker.grimm@ufz.de

Individual-based models (IBMs) are now an established tool in population ecology. However, IBMs are still, with the exception of forest ecology, not used very often to address questions regarding communities and ecosystems. Consequently, community and ecosystem models are often more conceptual than mechanistic. They are hard to test and they usually ignore individual-based aspects that have been shown to be relevant for populations. The main reason for this might be the notion that the complexity of IBMs, which already is a challenge for population IBMs, has to be multiplied for communities and ecosystems so that the resulting models cannot be handled any more. I will present examples of successful IBMs of communities and ecosystems. The modelling strategies employed so far are: modelling functional groups instead of species and focussing on key species. None of these approaches, however, allows to fully taking into account high species diversity, local interactions, and adaptive behaviour. I will discuss recent modelling approaches that would allow to go beyond the current state-of-the-art and I will list the challenges for putting these approaches into practice. One of the most important challenges is to develop models that allow including both plants and animals in a generic way. Approaches like the field-of-neighbourhood (FON) approach have this potential. In conclusion, I will argue that we badly need full-fledged IBMs of communities and ecosystems, but that we also need simpler models in order to explore the significance of individual-based aspects.

Multi-scale interactions in complex ecological systems: Integrating empirical data into model based representations

Fred Jopp (1) & Hauke Reuter (2)
(1) University of Miami, Department of Biology, P.O. Box 249118, Coral Gables, FL 33124, USA
(2) Center for Tropical Marine Ecology (ZMT), Fahrenheitstrasse 6, 28359 Bremen, Germany
e-mail: fredjopp@bio.miami.edu

On lower ecological levels a multitude of empirical results are available to describe species performance within their habitats. This specific species knowledge comprises information on physiological processes, behavioral reactions as well as intra- and interspecific interactions, often in the context of respective biotic and abiotic situations. Normally, this data quality can not be maintained for higher hierarchical levels. Consequently, for higher ecological scales a pattern-based approach dominates the view, which bases to a large extent on descriptive statistical methods. These methods are used to correlate ecosystem and landscape dynamics to developments on other hierarchical levels.

In many cases the relationships between processes on the level of single populations and the patterns on higher levels, such as food web interactions, biodiversity developments, establishing of invasive species or species extinction, can not be represented adequately. Currently, the development of suitable methodologies to bridge the gap between detailed ecological knowledge for single species and the overall developments in larger ecological systems is in the focus of attention in many ecological disciplines. In such a context, a decisive demand toward any methodology is the ability to deal appropriately with heterogeneities in space and time.

This paper presents an agent-based modeling framework that is used to incorporate and analyze a variety of knowledge and data from different ecological sub-disciplines and with different overall qualities which represent biotic interactions and dynamics across several ecological levels.

We applied this framework to a variety of heterogeneous data from own ecosystem case studies and literature studies on ecological issues, such as dispersal and population processes in invertebrates as well as food web interactions in small mammals, in order to demonstrate the integrative power of such a modeling framework. We will demonstrate the general applicability of such modeling tools to depict and assess spatially explicit heterogeneous phenomena that emerge over a variety of ecological scales.

Poster presentations

Alopecia in *Lemur catta* – further evidence for a connection with the introduced plant *Leucaena leucocephala*

Wiebke Berg (1), Jörg Ganzhorn (1), Alison Jolly (2)
(1) University of Hamburg, Department of Animal Ecology and Conservation, Martin-Luther-King Platz 3, 20146 Hamburg, Germany
(2) University of Sussex, Department of Biology and Environmental Science, UK

Severe alopecia has been observed in *Lemur catta* at Berenty Reserve, Madagascar, since 2001 (Bald Lemur Syndrome). Several investigations ruled out common diseases, ectoparasites and malnutrition but indicated a connection to the introduced plant *Leucaena leucocephala.* Leucaena is highly nutritious but contains mimosine, a toxic amino acid that inhibits cell division. Effects of toxicity include alopecia, anorexia, cataract, goitre and even death.

A study on feeding ecology and fur condition during 7 months between November 2005 and October 2006 strongly supports the possible connection between alopecic lemurs and *L. leucocephala*. Previous data on 20 females from four troops showed that higher amounts of leucaena in the diet correlated with a greater decrease in fur condition during the dry season 2005 (Rambeloarivony et al., in prep.). Subsequent data collection on three of these troops showed that the animals ceased leucaena consumption almost completely in November and December and resumed consumption from March to July in the following year. Two troops with little leucaena in their diet recovered during the wet season from a medium condition back to fully furred. In contrast, the troop that had consumed significantly more leucaena during the dry season 2005 remained in a bad condition throughout the wet season despite almost no leucaena intake. During the dry season 2006 the two better troops mostly consumed no more than 10% leucaena and their fur condition went from good to medium as in the previous year. The bad troop's diet, however, consisted of up to 69% leucaena and their fur condition decreased further from bad to worse, including several completely bald animals (Fig. 1). One bald female died. The other animals in this troop regrew fur between July and October. A time lag of ~3 months was found between leucaena intake and the response in fur condition. Finally, leucaena toxicity does not seem to directly influence reproductive success, although there is an indirect effect through reduced survival rates of juveniles.

The impact of *L. leucocephala* on wildlife has, to our knowledge, not been reported before. However, the highly invasive plant has been introduced throughout the tropics and subtropics and hence might affect many more species.

Figure 1: Bald *Lemur catta*

Electrophysiological study of pine volatile perception by a parasitoid of pine sawfly eggs

Ivo Beyaert, Nicole Wäschke & Monika Hilker
Freie Universität Berlin, Institut für Biologie, Haderslebener Str. 9, D-12163 Berlin

Egg deposition by the pine sawfly *Diprion pini* on Scots pine (*Pinus sylvestris*) is known to induce release of pine volatiles that attract the egg parasitoid *Chrysonotomyia ruforum.* The attractive oviposition-induced pine odour consists of numerous terpenoid compounds and differs from non-attractive pine odour especially by enhanced quantities of *(E)-β*-farnesene[1,2]. Behavioral bioassays revealed that this sesquiterpene is attractive to *C. ruforum* only when offered at the background of non-attractive pine odour. These previous results suggest that the egg parasitoid is attracted to oviposition-induced pine when a specific ratio of *(E)-β*-farnesene and other pine volatiles is released. However, which of the numerous "other pine volatiles" are relevant for attraction of *C. ruforum*? To approach this question we recorded electroantennogram (EAG) responses by female *C. ruforum* to six monoterpenes and six sesquiterpenes. These compounds were selected based on their chemical structure and abundance in attractive oviposition-induced pine odour. The following components elicited a response significantly different from the response to the solvent: the monoterpenes 3-carene, *β*-phellandrene and (*E/Z*)-β-ocimene, as well as the sesquiterpenes α-copaene, *(E)-β*-caryophyllene, *α*-humulene and *(E)-β*-farnesene. The electrophysiological results will be discussed with respect to the behavioural studies on the attractiveness of oviposition-induced pine odour.

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Influence of volatiles from egg-laden plants on host plant search by leaf beetle females

Beatrice Blenn & Monika Hilker
Freie Universität Berlin, Institut für Biologie, Haderslebener Str. 9, D-12163 Berlin, Germany

Interactions between herbivorous insects and plants are well known to be mediated by volatiles. Both feeding and egg deposition by herbivorous insects can induce changes of plant volatiles [1]. We investigated whether gravid females of the mustard leaf beetle (*Phaedon cochleariae*) discriminate between volatiles from egg-laden and egg-free leaves of Chinese cabbage (*Brassica rapa* ssp. *pekinensis*) and, if so, which factors are important for this discrimination. Mustard leaf beetle females always feed along with egg deposition. In olfactometer bioassays, we compared the females´ orientation to volatiles from feeding damaged, egg-free plants to those from feeding-damaged plants bearing eggs. The beetles significantly preferred volatiles from plants with feeding damage and eggs. Further bioassays revealed that egg deposition did not induce the plant to release the attractive volatiles, but instead a combination of egg volatiles and volatiles from feeding-damaged plants resulted in a blend attractive to *P. cochleariae* females. These results are in contrast to other studies which showed that egg deposition by herbivorous insects induced the plant to release volatiles affecting the herbivores or their natural enemies.

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Effects of changing temperature variability on the aboveground and belowground subsystem

Breulmann M. (1,2), Eggers T. (1), Möhlmeyer A. (1), Gromes R. (3)
(1) UFZ-Halle, Department of Soil Ecology, Theodor-Lieser-Str.4, D-06120 Halle, Germany
(2) University of Osnabrück, Ecology Division, Barbarastraße 35, D-49076 Osnabrück, Germany
(3) University for Applied Science, Osnabrück, Germany, Am Krümpel 23, D-49090 Osnabrück, Germany

Since the beginning of the 21st century temperatures increased by about 0,6°C and a further increase of about 1,4°C - 5,8°C till the end of the 21st century is predicted. Associated with increasing average surface temperatures is an increase in temperature variability. Current models predict an increase in inter-annual temperature variability of some 80% - 100 % in central Europe [1]. While the ecological consequences of rising average temperatures are well understood little is known about the impact of changing temperature variability on ecological processes in terrestrial ecosystems.

The objective of this experiment was to analyse the effects of temperature variability on both, an above-ground herbivore (*Rhopalosiphum padi*) and its host plant (*Agrostis capillaris*) as well as on subsequent feed forward effects on different soil parameters and processes. In addition, the novel experimental setup used had to be tested to provide information for future experiments. We conducted two climatron experiments with differing temperature variability of 11% and 76% respectively.

In this experiment, temperature variability showed very significant direct and indirect effects on soil chemical parameters of the rhizosphere (5-7cm) affecting the ammonium, phosphate, magnesium, calcium and the sodium content. New findings of this work are that increasing temperature variability appears to control herbivory. While population growth of aphids decreases, offspring increases. Soil parameters and soil enzymes in the upper soil layer (0-3cm) are regulated by both, changing temperature variability and above-ground herbivores. A number of soil enzymes such as the potential nitrification and the phosphatase are influenced by *R. padi*. Due to the massive honeydew production by aphids and the subsequent flux of saccharose on to the top soil, the activity of the saccharose is additionally influenced.

Further investigations on increasing variability of climatic factors such as temperature or precipitation are needed as the likelihood of future extreme climate events will rise [2-4] and yet the consequences for ecosystem functions and the services they provide are not well understood [5].

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Comparing diversity of *Abies alba* MiLL. and its ECM in an individual-by-individual approach in different populations

Eva Cremer (1,3), Katrin Donges (2), (both authors equally contributed), Sascha Liepelt (1), Karl-Heinz Rexer (2), Birgit Ziegenhagen (1) und Gerhard Kost (2)
(1) Philipps-University of Marburg, Faculty of Biology, Conservation Biology, Karl-von-Frisch-Str. 8, D-35032 Marburg Germany
(2) Philipps-University of Marburg, Faculty of Biology, Mycology, Karl-von-Frisch-Str. 8, 35032 D-Marburg Germany
(3) Present address: Bavarian Institution for Forest Seeding and Planting, Forstamtsplatz 1, D-83317 Teisendorf, Germany

Climate change will increase the impact of catastrophic storm events on our forest ecosystems. Reforestation of large-area windthrows will be left to natural regeneration. The stability of these establishing stands might be endangered by genetic depletion and decrease of the diversity of associated symbionts. Ectomycorrhizal (ECM) fungi are essential for the vitality and competitiveness of our forest trees. The strong interdependency of host plant and ECM-fungus suggests a close evolutionary of both partners.

Genetic differentiation of silver fir (*Abies alba* MILL.) was studied on regional, population and intrapopulation levels at 3 sites in the Northern Black Forest. Genetic distances and differentiation among populations were low. There was no evidence for significant spatial genetic structure within the silver fir populations. There was no difference in Nei´s gene diversity among different age classes.

Roots of every genetically characterized silver fir tree were screened for ectomycorrhizal (ECM) fungi. Fungal species were determined according to morphology and molecular characters (ITS nrDNA-sequencing).

Our results showed no relationship between different ECM partners and genetic structure of the host tree. But, there was higher species diversity on mature trees compared to young silver firs**.** Furthermore, significant differences in fungal species composition comparing the forest sites, as well as closed forest stands and windthrow areas were found.

While significant influences of storm events on the genetic structure of *Abies alba* stands could not be verified, these events clearly altered the ECM species composition on the disturbed areas.

Fish species community and local scale variables relationship in Greek Natura 2000 freshwater ecosystems

Evangelia Drakou (1), Bobori Dimitra (2), Mazaris Antonios (1), Kallimanis Athanasios (3), Sgardelis Stefanos (1) & John D. Pantis (1)
(1) Aristotle University, Department of Ecology, UPB 119, 54124, Thessaloniki, Greece
(2) Aristotle University, Department of Zoology, Laboratory of Ichthyology, UPB 134, 54006, Thessaloniki, Greece
(3) University of Ioannina, Department of Environmental and Natural Resource Management, 30100, Agrinio, Greece

Assessment of the local scale variables that control species richness is a central issue in ecology. Quantitative information on the spatial structure of freshwater ecosystems and fish assemblages is significant for the description of biodiversity patterns, and for water management and ecological monitoring.

The main objective of our study was to identify the most significant local scale variables affecting fish species diversity in freshwater ecosystems of the Greek Natura 2000 network. We investigated the relationship between the local scale variables (spatial pattern metrics, geographical data and distance between study sites) of 18 Greek freshwater ecosystems and the biological attributes of the native fish assemblages. Freshwater ecosystems data was obtained by the Natura 2000 network database (92/43/EEC) and fish assemblage data by FishBase.

We found that the number of native fish species was significantly correlated with ecosystems' trophic level, altitude and area. Furthermore, the diversity of habitat types was negatively correlated with the range of species trophic levels.

Distance between freshwater ecosystems was significantly related with fish species composition. As the distance between ecosystems increased, lake similarity according to fish species composition, decreased.

The local scale variables that best described fish species composition were ecosystems' area and shape metrics, habitat richness and fragmentation. The local scale variables that best described fish species trophic level were ecosystems' trophic status, depth, altitude, area and shape.

Thus, in Greek freshwater ecosystems, fish species composition is primarily affected by dispersal limitation and secondarily influenced by local scale heterogeneity.

Managing biodiversity from landscape to species scale using geospatial tools – A study from tropical rain forests of Western Ghats, India

Amarnath Giriraj (1), Murthy M.S.R. (2) & Carl Beierkuhnlein (1)
(1) University of Bayreuth, Department of Biogeography, 95440 Bayreuth, Germany
(2) National Remote Sensing Agency, Forestry and Ecology Division, 500037 Hyderabad, India

Trans-scale information on biodiversity is fast becoming the critical information for policy decision and action. Remote sensing systems addressing the structure and biophysical processes have the ability to achieve a seamless scalable information scheme. Necessity of down-scaling the coarse scale database to implementation scale is quite high under current circumstances, as practical schemes/measures to reverse the erosion of biodiversity are needed. The nesting of information required should address the landscape heterogeneity and stakeholder conflicts arising out of socio-economic dimensions. Species level distributions can be predicted based on genetic algorithm oriented fundamental niche mapping, enabling prioritization of areas for monitoring and conservation. Geoinformatics rendering of diversity on the principles of landscape ecology, integrated with spatialized anthropogenic demand patterns can be a potential interface to resolve conflicts in stake management.

Earthworms, mycorrhizae and the structure and diversity of grassland communities: the effect of earthworm activity

Barbara Heiner (1), Johann G. Zaller (1), Olaf Schmidt (2), Thomas Drapela (1), Birgit Putz (1), Thomas Frank (1)
(1) University of Natural Resources and Applied Life Sciences Vienna, Institute of Zoology, Gregor Mendel Straße 33, A-1180 Vienna, Austria
(2) UCD School of Biology and Environmental Science, University College Dublin, Belfield, Dublin 4, Ireland

Although earthworms, arbuscular-mycorrhizal fungi (AMF) and plants are key-organisms in grassland ecosystems, very little is known about the functional and structural interactions between these ecosystem components. The aim of this study is to test (1) if the activity of anecic and endogeic earthworms affects the distribution of AMF and (2) whether interactions between earthworms and mycorrhizae influence the establishment, diversity, productivity and functioning of grassland ecosystems. In contrast to previous studies, we combined all three groups of organisms in a full-factorial mesocosm experiment to assess whether 15 plant species native in temperate grasslands (grasses, non-leguminous herbs and leguminous herbs) differ in their response to nutrient and/or AMF patches in the soil created by earthworm casts.

To quantify the use by plant roots of nutrients from belowground earthworm casts, we used stable isotope labelling. Therefore, anecic (*Lumbricus terrestris*) and endogeic (*Aporrectodea caliginosa*) earthworms were raised in soil, enriched with ^{15}N and ^{13}C, producing labelled casts; a portion of casts was additionally inoculated with a mixture of AMF species (*Glomus intraradices*, *G. mosseae*, *G. geosporum*, *G. claroideum*). The casts were then transferred into plastic tissue capsules and inserted into the soil in mesocosms. This allowed roots to access nutrients and AMF present in casts, and also enabled earthworms to distribute nutrients and AMF throughout the soil profile. After two months of earthworm activity mesocosms were harvested. We measured above and belowground plant biomass, mycorrhizal colonization of roots, above- and belowground casting activity of earthworms and the distribution of isotopic tracers in the soil profile and plants.

Preliminary results indicate that (1) earthworm activity significantly altered the distribution of nutrients and AMF in the soil profile and among plant species and (2) plant species differed in their utilization of nutrients from casts. Our results demonstrate that both earthworm activity and AMF are important drivers of the development and structure of diverse grassland plant communities.

From individual behavior to population dynamics: Individual Based Models as a tool for conservation using Tawny owls as a case study

Rikke Anker Jensen (1), Peter Sunde (2), & Gösta Nachman (1)
(1) University of Copenhagen, Section of Biology, Department of Ecology and Evolution, Universitetsparken 15, 2100 Copenhagen-Ø,
(2) University of Aarhus, National Environmental Research Institute, Department of Wildlife Biology and Biodiversity, Grenåvej14, 8410 Rønde

Understanding causes and effects of ecosystem dynamics is much like finding needles in a haystack. The dynamics of ecosystems are made complex by the multitude of species making up the system, and the immense number of possible interactions between those individuals. Even the dynamics of a single species or population are governed by immensely complex processes, and many straws of hay will have to be removed before a needle is found. Most often we try to simplify the processes, looking for predictors that affect mean values of a population, e.g. mean mortality risk as a function of the distance to a road. Such approaches, however, do not consider individual behavior and interactions with the environment from which the dynamics arise.

Individual Based Models (IBMs) allow individuals to interact with each other and with the environment, giving new insight into population dynamics and ecosystem functioning. We develop an individual based model simulating the dynamics of a Tawny owl (Strix aluco) population in Denmark, allowing individuals to interact in a spatially explicit landscape according to their natural behavior. A successful simulation of the population dynamics, as observed during the past decade, will give way for simulations under changing conditions such as climate changes, anthropogenic fragmentation of the habitat, establishment of roads, change in forest practice etc. This will guide future management decisions and aid long term conservation efforts for this species.

When predicting the fate of populations we are restricted to using simplified models of very complex systems. IBMs contain actual knowledge of the species in question, but inevitably also numerous assumptions making the models complex, very species specific, and difficult to evaluate for outsiders. We aim at making our IBM so general that it, with few modifications, can be applicable to other species and by using the ODD-template [1] as a frame for our documentation so as to make it possible for others to evaluate its underlying assumptions.

We intend to use a modified version of our IBM to analyze possible causes for the rapid decline in the Danish population of Little owl (Athene noctua). This is a much less studied species for which conservation efforts are urgent, but resources (such as funding, time and knowledge of its population dynamics) are limited. An IBM will aid in identifying factors limiting the population growth and spread and thereby guide future management decisions.

[1] Grimm, V., Berger, U., Bastiansen, F., *et al.* 2006. A standard protocol for describing individual-based and agent-based models. *Ecological Modelling*, **198**, 115-126.

Cynipid–parasitoid interactions: Comparing three dog rose species along a geographical gradient

Annette Kohnen (1), Katrin Klinge (2), Volker Wissemann (3) and Roland Brandl (1)
(1) Marburg University, Department of Animal Ecology, Karl-von-Frisch-Strasse 8, D-35032 Marburg, Germany
(2) Göttingen University, Department of Agroecology, Waldweg 26, D-37073 Göttingen, Germany
(3) Giessen University, Department of Special Botany, Senckenbergstr. 17, D-35390 Giessen, Germany

Multitrophic interactions between plants, herbivores and natural enemies change with host species as well as geographic context. Thereby, the genetic variation between hosts affects not only herbivores but also the structure and dynamics of higher trophic levels.

In our study we examined interactions between the gall wasp *Diplolepis rosae* (L. (Hym.)) and its parasitoids on three dog rose species (*Rosa*, section Caninae) across Germany. Within 388 galls we found eight species of parasitoids (most common: *Orthopelma mediator* 18 %, *Glyphomerus stigma* 12 %, *Torymus bedeguaris* 9.1 %) and the inquilin *Periclistus brandtii* (12 %). Most galls were found on *R. rubiginosa* (mean: 5.9±1.4 bush^{-1}; *R. canina:* 1.8±0.1, *R. corymbifera*: 2.8±0.5; 133 bushes sampled). The abundance of galls bush^{-1} varied between sample localities ($F_{7,109}$=25, p<0.001), the rose species ($F_{2,109}$=25., p<0.001) and their interaction ($F_{14,109}$=2.9, p<0.001). The rate of parasitism and therefore the survival rate of *D. rosae* decreased with increasing gall volume ($F_{1,256}$=479, p<0.001) and varied between rose species ($F_{2,256}$=96, p<0.001). But in contrast to the abundance, the rate of parasitism was smallest for galls collected on *R. rubiginosa* (62 %, *R. canina*: 76 %, *R. corymbifera*: 76 %). Again the parasitism rate varied with sample locality ($F_{7,256}$=49, p<0.001), but showed no geographical gradient. Furthermore, host identity and locality showed a significant interaction ($F_{14,256}$=13, p<0.001). Overall our results show that host identity and geography interact in determining the structure of food webs.

Double stress for double effect: A combined approach of food competition and Bti application for mosquito control

Iris Kroeger (1), Sabine Duquesne (1,2) and Matthias Liess (1)
(1) Helmholtz Centre for Environmental Research – UFZ, Department of System Ecotoxicology Permoserstrasse 15, D-04318 Leipzig, Germany
(2) Helmholtz Centre for Environmental Research – UFZ, Department of Biology Conservation, Permoserstrasse 15, D-04318 Leipzig, Germany

Mosquitoes can heavily affect human health, as they are vectors for various diseases like Malaria or West- Nile Virus. Climate change (particularly parameters like warmer temperature and heavy rainfalls) can potentially induce a geographic redistribution of mosquitoes and pathogens from lower to higher latitudes.

For an optimised and environmentally friendly mosquito control strategy a combination of biological and chemical approaches was investigated. Biological interactions have a strong negative impact on mosquito larvae. Both microcosm and field studies showed that the presence of food competitors (Crustacean) did negatively affect mosquito larvae. Indeed species richness as well as density appeared as key parameters limiting mosquito larvae development.

The use of a combined application of Bti (*Bacillus thuringiensis israelensis*) and food competitors provided significantly better results compared to the single use of Bti. This effect was shown in outdoor microcosm studies and was also evaluated in the field, where similar trends were observed.

Our results showed, that natural mechanisms like food competition are important factors with a strong impact on the target organisms. In combination with conventional tools, i.e. pesticides, they can strongly improve sustainable mosquito control strategies.

Spatial variation of size structure in fish assemblages of a small non-tidal lagoon of Southern Italy (Acquatina, Lecce - ITALY)

Stefano Maci, Alberto Basset
University of Salento, Department of Biological and Environmental Sciences and Technologies; prov.le Lecce-Monteroni,73100 Lecce, Italy

Species distribution patterns depend on how the niche of environment meets the energetic, morphological and behavioural needs of individuals, as well as on biotic interactions. Functional traits are expression of those needs and reflect the modality of niche axes exploitation.

Among functional traits, body size is linked to individual energetic balance, to the perception of spatial-temporal patterns of resource availability, to the interactions with habitat structure and abiotic components. Thus size structure spatial patterns can be an useful tool to detect the main factors and mechanisms driving community organization.

In transitional water ecosystems, which are intrinsically selective, fish assemblages have been suggested to be shaped by abiotic gradients more than by competitive interactions promoting niche partitioning. However, in small transitional waters the relative importance of these two factors is unclear.

The present study was aimed to identify spatial patterns of fish assemblage size structure along the confinement gradient of a small non tidal lagoon of Southern Italy (Acquatina, Lecce – ITALY).

Fishes were sampled every two weeks between June 2007 and May 2008 by means of hoop-net systems, identified and counted. From a sub-sample of individuals, measures of standard length and wet weight were taken. Dry weights and ash contents were also measured and wet weight-dry weight relations computed. Mean body size frequency distributions were tested for differences among the four sampling stations located at growing distance from the inlet.

Results showed a pattern of increasing simplification of size structure along the confinement gradient, with a gradually narrower range of size classes and the shift of fish assemblage towards a predominant smaller-size class. These evidences suggest that in this small lagoon abiotic gradients filter species and individuals of similar size, probably the best adapted to local selective environmental conditions, and reduce the size differentiation expected to be one of the main factors allowing coexistence of species that share similar niches and exploit similar resources.

Above- and belowground trophic levels affect plant performance differentially along a nature-crop gradient

Katrin M. Meyer (1), Matthijs Vos (2), Wolf M. Mooij (3), Gera Hol (1) & Wim van der Putten (1)
(1) Netherlands Institute of Ecology NIOO-KNAW, Centre for Terrestrial Ecology, Department of Multitrophic Interactions, Boterhoeksestraat 48, 6666 GA Heteren, The Netherlands
(2) Netherlands Institute of Ecology NIOO-KNAW, Centre for Estuarine and Marine Ecology, Department of Ecosystem Studies, Korringaweg 7, 4401 NT Yerseke, The Netherlands
(3) Netherlands Institute of Ecology NIOO-KNAW, Centre for Limnology, Department of Food Web Studies, Rijkstraatweg 6, 3631 AC Nieuwersluis, The Netherlands

Trophic interactions are assumed to be stronger in agricultural than in natural systems due to greater herbivore and natural enemy searching efficiencies in monocultures. There is ample evidence that this is true for aboveground herbivores and parasitoids. However, the majority of these studies ignored that above- and belowground trophic levels may interactively affect plant performance.

We developed a computer simulation model to explore how the effect of the removal of trophic levels in an above- and belowground food web on plant performance changes along a gradient from natural to agricultural conditions. We simulated the gradient by simultaneously increasing nutrient supply, above- and belowground herbivore and natural enemy efficiency and decreasing plant defense induction.

With all trophic levels present, plant mortality as an inverse measure for plant performance increased from natural to agricultural conditions (Fig. 1). Among the second trophic levels, removal of belowground herbivores had a strong negative effect on plant mortality under more natural conditions while the positive effect on plant mortality through aboveground herbivore removal was apparent only towards the agricultural end of the gradient (Fig. 1). Among the third trophic levels, removal of belowground natural enemies had the greatest impact under natural conditions while removal of aboveground natural enemies affected plant mortality much less peaking more towards agricultural conditions (Fig. 1).

We conclude that belowground multitrophic interactions affect plant performance more strongly in natural systems, while aboveground multitrophic interactions are more important in agricultural environments.

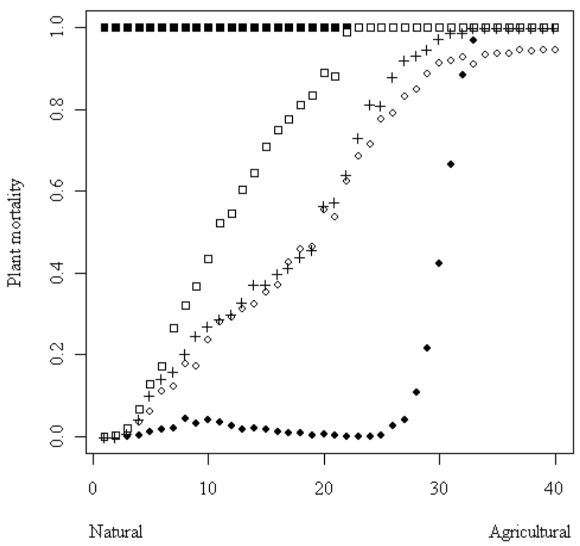

Figure 1: Plant mortality along a simulated gradient from natural to agricultural conditions with removal of different trophic levels. + all trophic levels present, ○ aboveground herbivores absent, ● belowground herbivores absent, □ aboveground natural enemies absent, ■ belowground natural enemies absent.

Earthworms, mycorrhizae and the structure and diversity of grassland communities: the role of AMF

Birgit Putz (1), Johann G. Zaller (1), Marcel van der Heijden (2), Wolfgang Wanek (3), Barbara Heiner (1), Thomas Drapela (1), Thomas Frank (1)
(1) University of Natural Resources and Applied Life Sciences Vienna, Gregor Mendel Straße 33, A-1180 Wien, Austria
(2) Forschungsanstalt Agroscope Reckenholz-Tänikon, Reckenholzstrasse 195, CH-8046 Zurich, Switzerland
(3) Department of Chemical Ecology and Ecosystem Research, University of Vienna, Althanstraße 14, A-1090 Vienna, Austria

Earthworms and arbuscular mycorrhizal fungi (AMF) are probably the most important groups of below ground biota in grassland. Earthworms make up the majority of soil faunal biomass while AMF form symbiotic associations with almost all grassland plants. Earlier work has shown that both AMF and earthworms play a key role in regulating grassland plant diversity. However, this earlier work studied AMF and earthworms separately and only little is known on how their interaction influences the structure and diversity of plant communities.

The main objective of the study was to test whether (1) AMF colonization of plant roots is influenced by earthworm activity, (2) AMF can alter root exudate utilization by earthworms and their activity and (3) this will be manifested in plant community structure. We investigated these interactions using a full-factorial design in mesocosms containing 15 different plant species (functional groups: grasses, non-leguminous herbs and leguminous herbs) representing a low-fertile grassland community. Functional links between the ecosystem components were tracked using stable isotopes applied onto leaves of particular plant species in the system. Studied earthworm species comprised the vertical burrowing anecic *Lumbricus terrestris* and the more horizontally burrowing endogeic *Allolobophora caliginosa,* both are common in temperate grasslands. AMF species used were the four widely distributed *Glomus intraradices, G. mosseae, G. geosporum, G. claroideum*.

Preliminary results indicate that anecic and endogeic earthworms differed in their influence on AMF distribution and root colonisation. Tested plant species responded differently to either earthworm activity or AMF inoculation. These data suggest that the structure and diversity of grassland ecosystem is shaped by plant species-specific differences in the dependence on earthworms and/or AMF colonization.

Assessing emergent properties in complex ecological networks – Application to aquatic environments

Hauke Reuter (1),Fred Jopp & Don DeAngelis (2)

(1) Center for Tropical Marine Ecology (ZMT), Fahrenheitstrasse 6, 28359 Bremen, Germany
(2) University of Miami, Department of Biology, P.O. Box 249118, Coral Gables, FL 33124, USA

Ecological systems are intertwined within complex networks of interrelationships. These networks emerge when a multitude of single entities react with each others in spatially and temporally heterogeneous settings over several hierarchical levels expressing a high number of interaction and feedback processes. In fact, this description of ecological systems does not only meet most criteria for complexity in general but is also an important reason why identifying the specific grain and extent for the focused phenomena still remains a priority assignment in ecology [1] and why only parts of the whole ecosystem are accessible to direct quantification [2]. In all ecosystems complex phenomena emerge with qualities which can not be deduced from monitoring and by decomposing the structural components of the higher levels. Instead, such forms of emergence are an essential part of the ecosystems self-organization processes.

In this presentation, we will show where and how emergent properties can occur in aquatic and semi-aquatic ecosystems. We will use methodologies that were developed in the context of the Northern German Lake Bornhöved Ecosystems Research project [3] and apply these to examples taken from the subtropical marshlands of southern Florida (Everglades National Park, USA).

Finally, we will show, how the concept of emergent properties can be used to enhance the understanding of complex ecological qualities and thereby, help to develop adaptive management strategies for complex ecological systems.

[1] T.F.H., Hoekstra, T.W., 1991. Role of heterogeneity in scaling of ecological systems under analysis. In: Kolasa, J., Pickett, S.T.A. (Eds.), Ecological Heterogeneity, Springer-Verlag, pp. 47–68.
[2] Reuter, H., Hölker, F., Middelhoff, U., Jopp, F., Eschenbach, C. & Breckling, B. 2005: The concepts of emergent and collective properties in individual based models - Summary and outlook of the Bornhoved case studies. Ecological Modelling 186: 489 - 501
[3] Reuter, H.; Jopp, F.; Hölker, F.; Eschenbach, C.; Middelhoff, U. & Breckling, B. 2007. The ecological effect of phenotypic plasticity --Analysing complex interaction networks with agent based models. Ecological Informatics 4: 35-45

Alternative measures of ecosystem function exhibit different variability patterns

Rocha, Marcia R. (1); Gaedke, Ursula (1); Vasseur, David A. (2)
(1) University of Potsdam, Institute of Biochemistry and Biology, Potsdam, Germany
(2) University of Calgary, Department of Biological Sciences, Calgary, Alberta, Canada

Standing stocks are typically easier to measure than process rates such as production. Hence, in the context of the diversity-variability debate they are often used as indicators of ecosystem functions although the latter are typically more strongly related to process rates. However, the regulation of standing stocks and process rates may differ greatly which may affect their variability patterns. Based on long-term high frequency measurements in a large, deep lake (L. Constance) we explore the variability patterns in primary and bacterial production and relate them to those of the corresponding standing stocks, i.e. phytoplankton and bacterial biomass. We have carried out spectral analysis of the long-term time series, which reveals all periodic components present in the data and allows the characterisation of temporal variability of the different groups as well as their comparison. We show that bacterial biomass and production exhibit a similar total variability at the annual scale, whereas the variability patterns of phytoplankton biomass and production exhibit some important and interesting differences throughout the year. Hence, measurements on biomass may provide misleading results on the variability of ecosystem functions as well as on the transmission of this variability throughout the food web. In addition, spectral analysis reveals how the variability patterns may be scale dependent.

Detecting plant-DNA within the gut content of herbivorous soil insects

Karin Staudacher, Corinna Wallinger, Nikolaus Schallhart, Michael Traugott
University of Innsbruck, Institute of Ecology; Mountain Agriculture Research Unit, Technikerstrasse 25, 6020 Innsbruck, Austria

The investigation of trophic relationships is crucial to understand the structure of floral and faunal communities and the interactions within them. Research on trophic relationships has concentrated on above-ground interactions so far, whereas there is only little information on below-ground trophic linking. Here we present a molecular approach allowing to study, for the first time, below-ground herbivory at a species-specific level.

Our project focuses on soil-insects, namely wireworms, the larvae of the click-beetles (Coleoptera: Elateridae), which are highly abundant below-ground herbivores and a serious pest worldwide.

General primers were used to sequence the plastid trnL (UAA) intron from various plant species present in grasslands and arable fields. Based on the aligned sequences species- and group-specific primers were developed, all of them targeting plants potentially fed on by wireworms. Primers were evaluated by testing their specificity against a wide range of non-target species (plants and animals). Besides, primer sensitivity was determined by serial dilution of plant-DNA in the presence of wireworm-DNA to determine the detection limits of the assay.

To evaluate our PCR-based plant DNA detection system, feeding experiments were conducted. Plant seedlings were offered to click-beetle larvae and batches of 10 wireworms each frozen at -28°C at 0, 4, 8, 16 and 24 hours post-feeding. Alternatively, maize (*Zea mays*) or wheat (*Triticum aestivum*) served as food sources to determine how long DNA form different plant species can be detected within the gut content of these soil insects. The outcomes of these experiments are the first step towards continuative investigations assessing the impact of plant diversity upon soil insect dietary choices.

Identification and sustainable use of ecosystem services

4.2. Agriculture, nature and biodiversity: Trade-offs between ecosystem goods and services?

Katarina Hedlund, Wim van der Putten

Oral presentations

Conflicting demands of land use, biodiversity and the sustainable delivery of ecosystem goods and services in agriculture

Katarina Hedlund
Lund University Department of Ecology, S22362 Lund, Sweden

Biodiversity is pivotal for delivering food, fiber and biofuels and carbon storage in agriculture. However, the demand of land is currently greater than the amount available, as production of biofuels competes with areas for food production and nature. Moreover, intensified land use reduces biodiversity and the resulting ecosystem services. This talk will give an overview of the current demands for land use in agriculture and how this match the demands for food and biofuels, when some systems are approaching the limits of their natural functioning or productive capacity. The most important ecosystem services in agriculture will be identified and different ways of valuing biodiversity through the impact on ecosystem services will be discussed. New approaches on how to develop ecological and economic models for valuing soil biodiversity in relation to ecosystem services will be presented in the talk.

Above-belowground interactions, functional biodiversity and ecosystem restoration

Wim van der Putten
Netherlands Institute of Ecology, P.O. Box 40, 6666 ZG Heteren, The Netherlands

A key characteristic of terrestrial ecosystems is that above and belowground communities interact. Still, many ecologists consider soil or aboveground subsystems in isolation. I will discuss recent work on above-belowground interactions and analyze the functional consequences of biodiversity for ecosystem restoration. Restoring (semi)natural ecosystems on ex-arable land provides an excellent model for testing and developing ecological concepts. I will combine results from a 12 year old land abandonment biodiversity experiment with results from a chronosequence study and show that legacy effects of soil communities have major impacts on the development of plant and aboveground community composition. Thus, present conditions in the field are the result of legacy effects from the past. I will discuss these findings in relation to land use changes, including the current policy of stimulating biofuel production.

Soil C&N storage: trait of or trade-off with diversity restoration?

Gerlinde De Deyn (1), (2), Helen Quirk (1), Simon Oakley (2), Niall McNamara (2), Nick Ostle (2) & Richard Bardgett (1)

(1) Lancaster University, Soil and Ecosystem Ecology, Library Avenue, LA1 4YQ Lancaster, U.K.
(2) Centre for Ecology and Hydrology, Library Avenue, LA1 4AP Lancaster, U.K.

Agricultural intensification has increased primary productivity, but reduced biodiversity, due to nutrient enrichment and habitat fragmentation [1]. To counteract species loss, agri-environment restoration schemes were implemented across Europe. Biodiversity restoration in grasslands with a history of intensive management requires the long-term cessation of fertilizer application and the seeding of target plant species [2]. Intensive land use not only affects diversity, but may also trigger rapid loss of soil carbon [3]. Plant diversity on the other hand can promote the sequestration of carbon (C) and nitrogen (N) in grasslands by enhancing productivity [4]. Grassland restoration of improved grasslands, however, initially aims at reducing productivity in order to enable establishment of sub-ordinate target species [2]. Soil C restoration through agricultural de-intensification, hence, requires alternative mechanisms.

Here we test whether restoration practices (seed additions and cessation of mineral fertilizer application) enhance soil C and N sequestration in a long-term hay meadow restoration field trial in the Yorkshire Dales [2]. In July 2006, plant species abundance cover was recorded and samples of vascular plants, mosses, litter, root and soil were collected. Concentrations of C and N in soil and vegetation were determined with a CN elemental analyzer and multiplied by the dry weights per m^2. For soil different size fractions were determined, because soil C is retained longer in fine than in coarse soil fractions [5]. Plant species richness was enhanced by long-term seed additions, but did not stimulate C and N pools in vegetation or soil after 16 years of being implemented. However, seeding of *T. pratense*, which was introduced in 2004, increased C and N pools in soil by 10%. Strikingly *T. pratense* seeding did not alter C and N content in vegetation and represented only 1.5% of the plant cover. Year-round field CO_2-flux measurements revealed that the addition of *T. pratense* significantly reduced respiratory C loss from soil and stimulated microbial C and N content. In contrast, the application of fertilizer increased respiratory C loss from soil and stimulated the loss of C and N in soil leachates. These results suggest that the form of N (mineral versus biochemically fixed) provided to N-limited systems and the presence of key plant species can have significant implications for soil C and N dynamics in grassland systems. Moreover our results demonstrate the unifiability of restoration management for both biodiversity and soil C and N sequestration.

[1] Walker, K.J. *et al.* (2004) The restoration and re-creation of species-rich lowland grassland on land formerly managed for intensive agriculture in the UK. *Biological Conservation* 119, 1-18.
[2] Smith, R.S. *et al.* (2008) Long-term change in vegetation and soil microbial communities during the phased restoration of traditional meadow grassland. *Journal of Applied Ecology* 45, 670-679.
[3] Lal, R. (2004) Soil carbon sequestration impacts on global climate change and food security. *Science* 304, 1623-1627.
[4] Tilman, D. *et al.* (2006) Carbon-negative biofuels from low-input high-diversity grassland biomass. *Science* 314, 1598 -1600.
[5] Jones, M.B. & Donnelly, A. (2004) Carbon sequestration in temperate grassland ecosystems and the influence of management, climate and elevated CO_2. *New Phytologist* 164, 423-439.

Lower N losses in fungal-based systems

Franciska T. de Vries (1,2), Jan Willem van Groenigen (1,2), Ellis Hoffland (1), Lijbert Brussaard (1) and Jaap Bloem (2)
(1) Wageningen University and Research Centre, Dept. Soil Quality
(2) Alterra, Soil Sciences Centre. P.O. Box 47, NL-6700 AA Wageningen, The Netherlands

It has been hypothesised that a high fungal/bacterial ratio can be indicative for systems with low nitrogen losses. Here, we tested this negative relationship between N losses and fungal biomass in a pot trial.

We selected two plots from one experimental grassland site: one with a high fungal/bacterial (F/B) ratio that had been fertilised with farm yard manure at a rate of 40 kg N ha^{-1} y^{-1}, and one with a low F/B ratio that had been fertilised with the same manure at a rate of 80 kg N ha^{-1} y^{-1}. While this difference in F/B ratio has been consistent for over 4 years, other soil characteristics did not differ between these soils. Intact soil columns from the two soils were incubated in the greenhouse for 4 weeks, receiving weekly rainfall events. We added inorganic fertiliser to half of the columns, resulting in a 2x2 factorial set up of four treatment combinations: 1) low F/B ratio unfertilised, 2) low F/B ratio fertilised, 3) high F/B ratio unfertilised, 4) high F/B ratio fertilised.

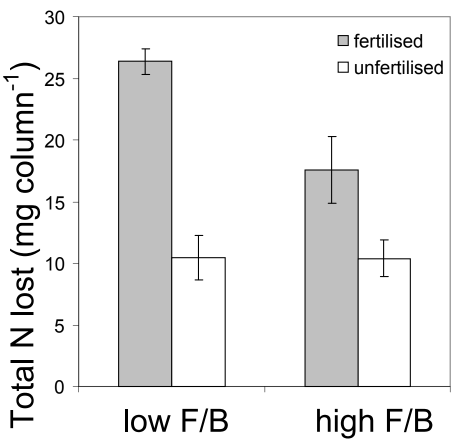

Figure 1: Total N lost from the different treatments. Bars represent

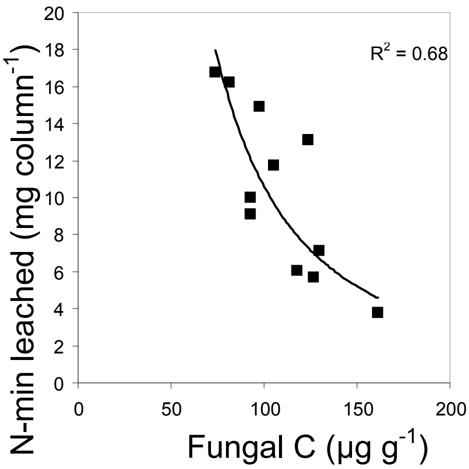

Figure 2: Relationship between mineral N leached and fungal biomass in the fertilised treatments.

Fertilisation increased mineral N leached from the low F/B soil dramatically, whereas in the high F/B soil, mineral N leached did not differ between the fertilised and the unfertilised treatment. Conversely, fertilisation increased denitrification in both soils and, irrespective of fertilisation, denitrification was higher in the low F/B soil than in the high F/B soil. Total N lost as a consequence of fertilisation in the low F/B soil was significantly higher than in the high F/B soil. We found a strong relationship between fungal biomass and N losses. However, the mechanisms we investigated–microbial immobilisation, increased plant N uptake through mycorrhizal fungi, and increased organic matter protection through fungal-associated aggregates–did not yield any significant differences between treatments. Therefore, we conducted a second experiment using ^{15}N fertiliser, of which I hope to present the results.

Microbial species loss changes above-belowground interactions

Gera Hol, Katrin M. Meyer, Wietse de Boer, & Wim van der Putten
Netherlands Institute of Ecology NIOO-KNAW, Centre for Terrestrial Ecology, Boterhoeksestraat 48, 6666 GA Heteren, The Netherlands

As a result of increasing awareness of ongoing climate changes, energy demands are to be fulfilled in a more sustainable way. Currently the production of energy from biomass has received a lot of attention and has been stimulated by international policy. However, growing crops especially for biofuel production will put more pressure on land use, resulting in further intensification with increasing inputs of fertilizers and pesticides. The consequences of this intensification for biodiversity and subsequent ecosystem services are not known, but most likely it will cause biodiversity loss. We will present results of a study analyzing how loss of soil biodiversity may change plant performance and interactions with aboveground plague organisms.

Opposite to how many biodiversity studies have been designed, species loss is not a random process. Species loss will depend on, for example, abundance and sensitivity to disturbances. We used a soil dilution technique where (serial dilutions of) microbial suspensions were inoculated into sterilized soils in order to create soils that differ in biodiversity. In this way, the High diversity treatment contains most low-abundant species, in addition to abundant species. The Low diversity treatment contains abundant species only, since low-abundant species disappeared after dilution.

Plant biomass was reduced in High diversity soil. Nitrogen levels and glucosinolate concentrations in the shoots were lowest in plants growing in High diversity soil. The effect of nematodes and aphids on plant quality depended on the microbial community composition. Nematodes did less damage to plants in the Low diversity soil compared to plants in the High diversity soil. Aphids reduced levels of amino acids in the plants in High diversity soil, but increased levels in plants in Low diversity soil. For glucosinolates the results were opposite: aphids induced glucosinolates in plants in High diversity soil, but reduced levels in Low diversity plants. Nematodes always had a negative effect on body size of aphids, but the effect was strongest in the Low diversity soil.

Other studies that used dilution-to-extinction approaches to get insight in the relation between microbial biodiversity and function pointed at high redundancy for specific ecosystem processes, such a mineralization and nitrification. In our experiment, we did not measure a single process but rather the sum of many processes, which showed us that the soil microbial community reduced plant biomass and complicated multitrophic interactions.

Above and below ground responses to a traditional low input agricultural system

Stefanie Vink (1), Roy Neilson (1), David Robinson (2) and Tim Daniell (1)
(1) Environment Plant Interactions, SCRI, Invergowrie, Dundee DD2 5DA, UK
(2) School of Biological Sciences, University of Aberdeen, Aberdeen AB24 3UU, UK

Machair is a traditional low input agricultural system found on the north and west coasts of Scotland and Ireland. It is renowned for its carpet of flowers in summer and supports a rich invertebrate fauna and substantial populations of ground nesting birds. Traditionally the machair is cropped on a rotational basis, generally 2 years of mixed cropping followed by 2 years fallow, with farm saved seed of rye (*Secale cereale*) and small oats (*Avena strigosa*) the main crop. Fertilisation with seaweed is common practice, but its use is declining and it is now often mixed with artificial fertiliser. Most of the machair, including cropped and fallow areas, is seasonally, extensively grazed by sheep and cattle. Upkeep of the machair is dependent on active management with both decreasing and increasing management leading to deterioration of this system. Additional threats to the machair system include drainage, increase in livestock stocking rates and grassland ‘improvement’ such as re-seeding.

Intensification of traditional low input agricultural systems has contributed to the loss of diversity both above and below ground. The diversity of micro-organisms in organic and low input agricultural systems is reported to be higher than that in intensely managed farms potentially making such systems more sustainable and resilient to disturbance.

Mycorrhiza and eubacteria, two key components of soils, are important determinants of ecosystem processes driving above ground community composition. In comparison to the studies conducted on machair vegetation and despite the potential importance of these below ground components there has been little study of these communities in the machair soils.

A study examining variation in the bacterial and mycorrhizal community structure of machair soil and vegetation was conducted in 2007. Individual cores containing soil and roots of each of two plant species were taken at three different times, at ten different locations and with three different land uses. DNA was extracted from two soil fractions (bulk and rhizosphere) and roots from each core. Ribosomal gene targets were amplified by PCR and community structure of eubacterial and AM fungi assessed with Terminal Restriction Fragment Length Polymorphism (T-RFLP). In addition, a survey of the plant communities was carried out at the summer sampling point.

Principal component analysis of the T-RFLP patterns shows that the microbial community reflects the variation in land use on the machair. There are significant temporal ($P<0.001$), land use ($P<0.001$), soil fraction ($P<0.001$) and vegetational ($P<0.001$) influences with a number of interactive effects. Results also suggest a link between the above ground vegetation, below ground bacterial community and moisture content of the soil within the different land uses and soil fractions.

Preliminary results of the AM fungi community structure analysis show significant host species ($P<0.001$), temporal ($P<0.01$), location ($P<0.01$) and land use ($P<0.05$) effects. There are also significant interactions between plant species and other factors.

Biodiversity and the landscape ecology of agri-environment schemes

Henrik Smith (1), Erik Öckinger (2) and Maj Rundlöf (1,2)
(1) Department of Ecology, Lund University, Sweden
(2) Swedish Agricultural University, Uppsala, Sweden

Agricultural landscapes in Europe have experienced severe losses of biodiversity. These declines have been attributed to agricultural intensification and the resulting loss of heterogeneity at multiple spatial and temporal scales. To alleviate the effect of agricultural intensification, farmers are compensated via agri-environment schemes for carrying out farming in ways to preserve and restore biodiversity. However, the effectiveness of these schemes in preserving biodiversity has been questioned. Several studies have tried to evaluate the effect of these schemes by performing "space-for time substitution" studies, in which carefully matched farms with and without agri-environmental measures have been compared. These studies have produced partly contrasting results. However, one aspect that has received less attention is how the spatial context and configuration of agri-environment measures affect the results. We have evaluated the consequences of the spatial context of organic farming and other agri-environment measures on the abundance and diversity of pollinators. We demonstrate that the effect of agri-environment schemes on pollinator diversity depends on both landscape complexity and the proportion of the landscape that is under agri-environment schemes. We discuss implication this have for the formulation of efficient agri-environment schemes.

The importance of agricultural management for biodiversity in hedgerows

Beate Strandberg & Marianne Bruus
University of Aarhus, National Environmental Research Institute, Dept. Terrestrial Ecology, DK-8600 Silkeborg, Denmark. bst@dmu.dk

Hedgerows play an important role in the fragmented agricultural landscape as corridors between natural habitats. Hedgerow vegetation acts as a necessary structural support for many insects and also plays an important role as food source for insects and birds. Thus hedgerows may contribute significantly to biodiversity in the agricultural landscape.

Agricultural practice and herbicide usage in particular affect the hedgerows. Herbicides reach the hedgerows as spray drift and affect both hedge plants and bottom vegetation. Omitting herbicides as in organic farming significantly increases hedgerow biodiversity. Assessment of vegetation and insects within hedges at about 80 farms showed that there are significantly more plant and insect species in hedges at organic farms than at conventional farms. Furthermore, the plant species have significantly more flowers per plant, flower at higher frequencies and flower for a longer period in hedges at organic farms compared with hedges at conventional farms. The main difference between the studied hedgerows is that hedges at organic farms were established and managed without the use of pesticides. Time since transition to organic management, however, also plays an important role for hedgerow biodiversity (Figure 1). The numbers of plants and insects start to increase after four years of organic management, but species number continue to increase for 15 to 20 years after transition.

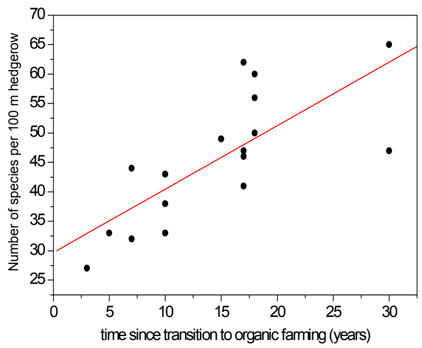

Figure 1. Relationship between biodiversity indicated as number of plant species per 100 meters of hedgerow and time since transition to organic farming

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The field observations were supplemented with laboratory studies. When exposed to herbicide dosages similar to spray drift dandelions (*Taraxacum* sp.) and red clover (*Trifolium pratense*) developed significantly reduced numbers of flowers per plant, and their flowering was delayed.

Controlled field experiments have also shown that the fruit yield of common hedgerow trees such as hawthorn, elder and Swedish whitebeam is reduced at herbicide dosages corresponding to spray drift.

The effects on biodiversity of other measures such as spay-free zones that reduce the herbicide exposure of the hedges are discussed.

Impacts of vegetation cover and crop identity on weed seed predation

Helmut Meiss (1), Lise Le Lagadec (1) Sandrine Petit (1) & Rainer Waldhardt (2)
(1) Institut National de la Recherche Agronomique (INRA), UMR 1210 Biologie et Gestion des Adventices, 17 rue Sully, BP 86510, F-21065 Dijon cedex, France. Mail: helmut.meiss@dijon.inra.fr
(2) Institute of Landscape Ecology and Resource Management, Justus-Liebig-University Giessen, Germany.

Weed seed predation is an important ecological service in agro-ecosystems for two reasons: 1) It may have strong impacts on plant demography and, because of seed preference, may alter the plant community composition. 2) In farmed landscapes, weed seeds may be used as an important trophic resource by a large number of taxa (*e.g.* ants, beetles, earthworms, rodents, birds) including many endangered species [1]. Using an experimental approach (seeds glued on sandpaper cards that were pinned on the soil surface[2]), we recently observed high seed predation rates (19-84% per week depending on weed species) [3]. But little is known about the factors determining seed predation. For weed management issues, it would be interesting to know if vegetation cover tends to increase or to reduce seed predation rates[2, 4]. In spring 2008, we tested this by comparing seed losses of three common weed species in a set of crop types with contrasting vegetation covers (Fig 1). Mean predation rates on open seed cards were 53% for *Viola arvensis,* 20% for *Alopecurus myosuroides,* 9% for *Sinapis arvensis* and 0.1% for artificial plastic globules (used as a negative control). This preference order agrees well with our last year results [3]. Seed predation rates appeared to be highest in lucerne crops (*e.g.* 100% for *V. arvensis* seeds), intermediate in spring barley (62%) and lowest in both grassy crops, *Dactylis* (30%) and *Festuca* (23%), but also on bare soil (30%, Fig. 1). Therefore, crop *identity* seems to play a more important role than actual vegetation cover (crop biomass). However, this pattern was different for seed cards put in 12mm-wire cages excluding (at least) all 'large' seed predators (rodents, birds). This was generally lowering the predation rates and most seeds were eaten in barley plots and on bare soil (Fig. 1), indicating that 'small' seed predators (invertebrates) might prefer less dense vegetation, at least in spring. There were virtually no seed losses on cards placed in 1mm-wire cages, which were used as a 2nd negative control.

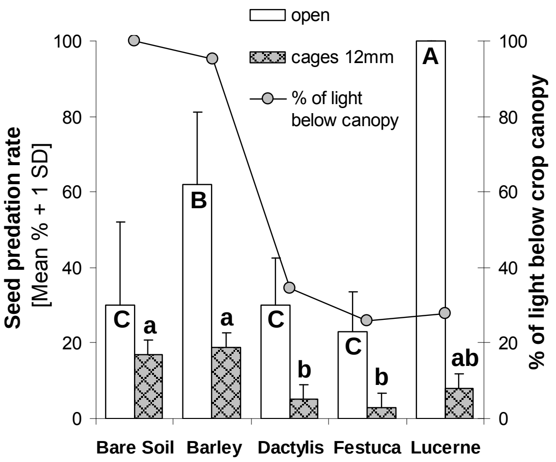

Fig. 1: Mean predation rates of *Viola arvensis* seeds during two weeks (t-tests, α=0.05, n=4) in different crops with contrasted vegetation covers.

[1] Moorcroft *et al.* (2002) The selection of stubble fields by wintering granivorous birds reflects vegetation cover and food abundance. *J. Appl. Ecol.* **39**, 535-547.
[2] Westerman *et al.* (2003) Annual losses of weed seeds due to predation in organic cereal fields. *J. Appl. Ecol.* **40**, 824-836.
[3] Alignier *et al.* (2008) Variation of post-dispersal weed seed predation according to weed species, space and time. *Journal of Plant Diseases and Protection* ***XXI,*** 221-226. **abstract too long/cut**

Bumblebee decline in pastoral landscapes within Ireland

Veronica Santorum and John Breen
University of Limerick

The presence of pastureland within landscapes has been identified as a positive factor that enhances conditions for bees [1]. However, pasture per se is not necessarily favourable for bumblebees. This presentation will provide evidence to show that pastoral farming, as it intensifies, is damaging bumblebee populations in Ireland.

The diversity and abundance of bumblebees in a less intensively farmed region, the Burren in County Clare, will be compared with that of a more typical modern pastoral region in Counties Limerick and Tipperary. The surveys were carried out in 2003-04. Yellow pan traps and transects were used at 28 'typical modern' pastoral farms and at 11 locations within the Burren region. Sample rarefaction was used to compare the species diversity of the two agricultural areas. Reduced species diversity was observed on 'typical modern' farmland [1].

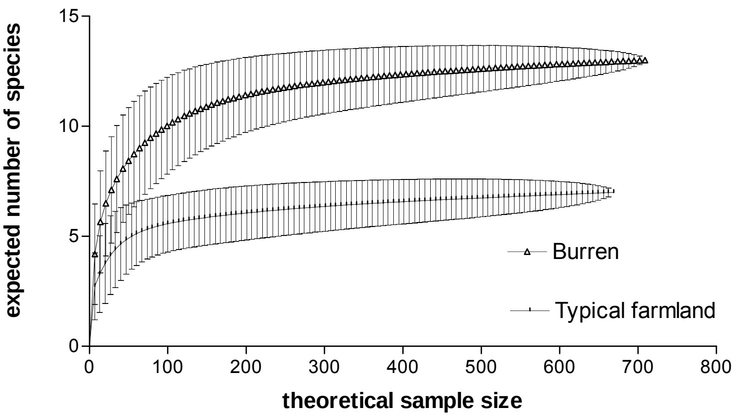

Figure 1: Sample rarefaction curves for pastoral farmland in the extensively farmed Burren region and 'typical' intensive farmland in the south-east of Ireland showing 95% confidence limits.

Examination of a collection of bees from the 1970s suggested that the missing species were more widespread in the past. Corroboration that these species were more widespread in the recent past was provided by an examination of range decline since 1980 of each species within Ireland, by Fitzpatrick et al. [2].

The discussion will also draw upon data from a subsequent survey of 50 farms of differing management intensity, located within different pastoral landscapes, to examine how bumblebee declines may be minimised within such landscapes.

[1] Santorum, V. and Breen, J. (2004) Bumblebee diversity on Irish farmland, *Tearmann: Irish journal of Agri-environmental Research*, 4, 71-82.
[2] Fitzpatrick, U., Murray, T.E., Paxton, R.J., Breen, J., Cotton, D., Santorum, V., and Brown, M.J.F. (2007) Rarity and decline in Irish bumblebees – A test of causes and correlates in the Irish fauna, *Biological Conservation,* 136, 185-194

The impact of pesticide pressures on pollinator diversity at different spatial scales

Claire Brittain (1), Marco Vighi (2), Riccardo Bommoarco (3), Josef Settele (4) & Simon Potts (1)
(1) Centre for Agri-Environmental Research, University of Reading, Reading RG6 6AR, UK
(2) Dipartimento di Scienze dell'Ambiente e del Territorio, Università di Milano Bicocca, 20126 Milano, Italy
(3) Department of Ecology, Swedish University of Agricultural Sciences, Uppsala, Sweden
(4) Department of Community Ecology, Helmholtz Centre for Environmental Research - UFZ, Halle, Germany

Pollinators are important to biodiversity in terms of their innate conservation value and also the ecosystem service they provide. Evidence of a decline in pollinators has been increasing with pesticides suggested as one of the causal factors [1]. Field data is needed to understand how lab derived toxicity levels relate to effects observed in the field. This study aimed to quantify the impacts of an insecticide on pollinators in an intensive agro-ecosystem, using vine fields in northern Italy as a model system. Sites were utilized where the distribution of the insecticide had been modelled spatially explicitly and the predicted exposure mapped down to the individual field level [2]. This allowed pollinator diversity to be related directly to insecticide levels in a typical agro-ecosystem.

Two spatial scales were explored: the individual field scale and the landscape scale studying different land use types. Bee and butterfly diversity was sampled using pan traps, trap nests and walking transects. At the field scale the number of bee species decreased significantly after two insecticide applications. At the landscape scale the number of bee species declined towards the end of the season only in vine fields where the insecticide was applied (Fig.1). Both results point to accumulation being a key factor behind the negative impacts of insecticides on bees. This suggests spraying late in the season should be avoided and where insecticides are necessary those requiring fewer applications should be chosen. Given the importance of pollinators, information such as this is important to help take the most appropriate conservation action.

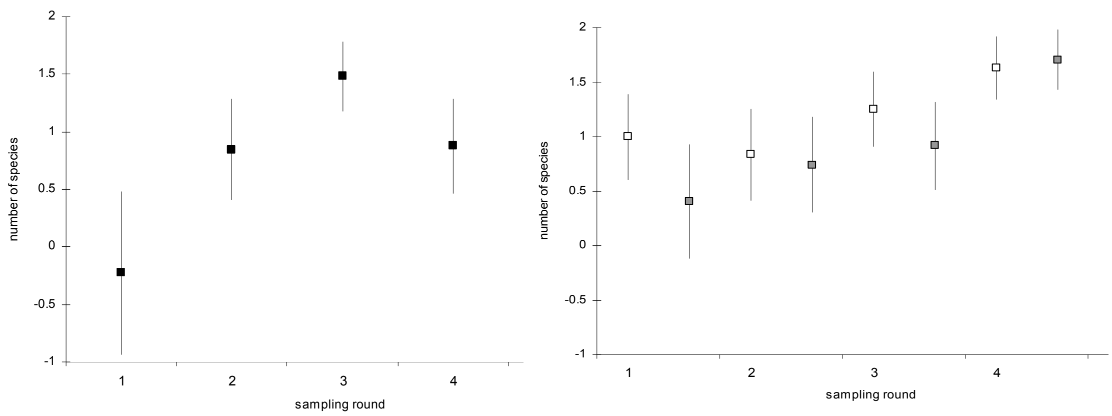

Figure 1: The mean number of species (± 95% confidence intervals) in four sampling rounds undertaken through the season. Vine fields in black, maize in white and uncultivated in grey.

[1] Allen-Wardell, G. (1998) Conservation Biology 12: 8-17.
[2] Bonzini, S. (2006) Environmental Science and Technology 40: 7561-7569.

Soil environmental functions and prospects of their evaluation

Radoslav Bujnovský (1), Jozef Vilček (2)
(1) Soil Science and Conservation Research Institute; Gagarinova 10, 827 13 Bratislava, Slovak Republic
(2) Regional branch of Soil Science and Conservation Research Institute; Raymanova 1, 080 01 Prešov, Slovak Republic

Soil plays important role in functioning of ecosystems and primarily influences the development of society. Similarly as ecosystem this natural resource provides many services and goods [1] that in soil science are defined as soil functions [2]. Besides biomass production, that is possible economically evaluate, the soil provides other ecological functions that are priceless for the society. To this group belong the regulation of water and substances cycle in the environment (filtration of substances, accumulation of water, regulation of environment/soil change - buffering function, substances transformation) and the creation of habitat for organisms & gene reserve. More over soil provides several socio-economic functions that usually are in contrary to ecological ones. Otherwise soil also contributes to formation of cultural and ecological landscape value.

Sustainability of societal development requires maintenance of soil quality and soil functions - especially the ecological ones. Besides direct application of principles of good soil use and management as preventive measure against soil degradation, the evaluation of soil functions can be considered as additional way for soil evaluation and development of more complex economic instruments for soil taxation - as regulative measure to moderate the permanent soil sealing for infrastructure building, house construction and industry development. Besides definition of basic principles for evaluation of selected soil functions it is necessary to search ways for economic valuation that can be considered with regard to modification of agricultural soil taxation especially to its permanent sealing.

Economic valuation represents the second step in soil function evaluation through soil quality index. For example estimation of potential of soil to accumulate water is based on water retention capacity and soil depth. Average values of water retention capacity are calculated on the basis of soil texture classes and multiplied by soil depth. In economic valuation of water retention, soil is regarded as reservoir whereby average cost of artificial basin is considered to be 60 SKK (1 € = 32.4 SKK) per 1 m^3. In average, one square meter of agricultural soils in Slovakia has value 16 SKK.

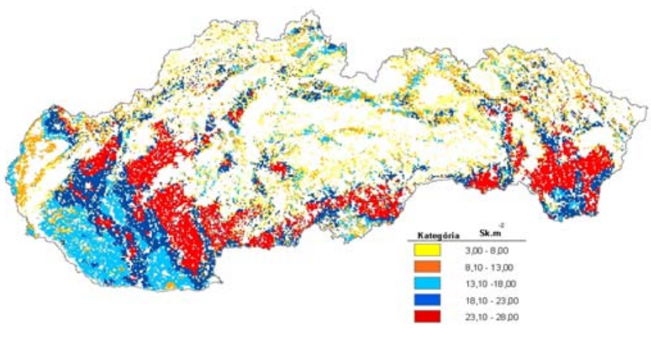

Fig 1: Price of soil potential to accumulate water

[1] deGroot,R.S., Wilson,M.A., Boumans,R.M.J., 2002. A typology for the classification, description and valuation of ecosystem functions, goods and services. Ecological Economics 41, 393-408
[2] Blum, W.E.H., 1993. The challenge of soil protection in Europe. Environ. Conserv. 17, 72-74

Model-based assessment of the viability of a semi-arid lakefish population under variable water inflow conditions

Romina Drees, Maja Schlüter & Karin Frank
Helmholtz Center for Environmental Research, Department of Ecological Modelling; Permoserstr. 15, 04318 Leipzig, Germany

The resolution of water-resource use conflicts in river basins requires a reliable evaluation of the available water-related ecosystem goods and services, their dynamic behaviour and management. To balance water allocation among different users it is necessary to identify the quantities and characteristics of the spatio-temporal water flow that determines species abundance dynamics and the viability of floodplain ecosystems.

In the Amudarya river delta in Uzbekistan, stakeholders manage the distribution of the river flow to maintain their economic production and income generation, or more precisely: to diminish their losses due to stochastic environmental impacts such as drought. In doing so, they face a tradeoff in resource use by irrigated agriculture and lake fisheries.

We simulate the demography of a fresh-water fish species linked to a variable hydrological regime with an integrated modelling approach to assess the impact of the regime on population viability. The population growth model consists of a stage-structured Leslie-type matrix model. Fish reproduce in the shallow coastal area of the lakes where they are strongly impacted by fluctuations in the water level. We analyze the impact of different water flow scenarios on the viability and age structure of population. Comparison of different river flow scenarios contribute to a quantitative evaluation of freshwater requirements of viable fish populations in a highly variable environment.

First simulation results (Fig. 1) show different recovery times of abundances after a perturbation at the simulation start. Scenarios also differ in their suitability to provide resilience buffers.

By evaluating resilience mechanisms, we contribute to current discussions about water distribution conflicts, which will hopefully lead to sustainable exploitation of ecosystem services within the case-study region.

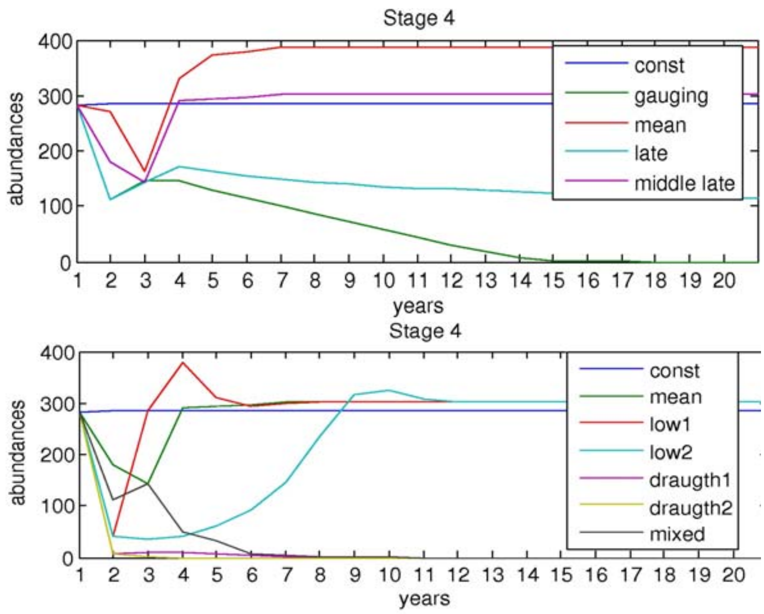

Figure 1: Comparison of stage abundances under different water flow regimes. Upper figure presents a simulation run with the same repeated scenarios for every year which result in a stable stage distribution or extinction of the population. The lower figure shows scenarios with different initial conditions.

Alteration of arbuscular mycorrhizal fungi communities assembled in roots in response to pre-inoculation with non-indigenous AMF species.

Daniel L. Mummey (1), Matthias C. Rillig (2)
(1) Division of Biological Sciences, University of Montana, Missoula, MT, USA
(2) Freie Universität Berlin, Institut f. Biologie, Berlin, Germany

Arbuscular mycorrhizal fungi (AMF) are obligate biotrophs that form symbiotic associations with the majority of terrestrial plant species. Due to their salient roles in plant nutrient acquisition, there is considerable interest in using AMF as "bio-fertilizers". Indeed, pre-inoculation of seedlings with commercial, typically non-indigenous, AMF species has become common practice in the horticultural and land reclamation industries. Although frequently viewed as ecologically friendly or benign, very little information is available regarding how non-indigenous AMF inoculants influence indigenous AMF communities [1]. In this study we specifically examine how AMF pre-inoculation influences the structure of AMF communities that subsequently assemble within roots of seedlings after planting in field soil. We exposed seedlings to five different AMF treatments (preinoculation with Glomus A, Glomus B, one of two Gigaspora sp., or no AMF) for 30 days prior to planting in a whole-soil, mixed AMF community inoculum. After a growth period of 75 additional days, the plants were harvested and aboveground biomass and foliar nutrient concentrations determined. AMF community composition was analyzed in roots collected away from the initial inoculum sites using an approach combining LSU rDNA sequencing and T-RFLP analysis. Our results indicate that the AMF communities that assembled within roots were strongly influenced by the identity of the AMF species to which seedlings were initially exposed. Pre-inoculation with Glomus A or Glomus B representatives greatly decreased the richness of other AMF ribotypes subsequently colonizing roots. In contrast, pre-inoculation with either Gigaspora species didn't significantly influence overall AMF ribotype richness. Our results also indicate that, concurrent with changes in AMF communities, changes in AMF community functionality, as indicated by differences in plant aboveground biomass and foliar P content, also occurred. Our results indicating the potential for exclusion of indigenous AMF species may have important implications regarding the introduction of non-indigenous AMF and serves to highlight the importance of considering life-history differences when designing AMF inoculants [1].

[1] Schwartz MW, Hoeksema JD, Gehring CA, Johnson NC, Klironomos JN, Abbott LK, Pringle A (2006) The promise and the potential consequences of the global transport of mycorrhizal fungal inoculum Ecology Letters 9, 501–515

Poster presentations

Impacts of energy crops on biodiversity and ecosystem services in Ireland

Jens Dauber, Mike Jones & Jane Stout
Trinity College Dublin, School of Natural Sciences; Dublin 2, Ireland

Climate change is one of the most pressing issues facing society today. To tackle climate change and ensure continued economic growth, the world's economies need to establish a sustainable energy supply. Ireland, like many other EU countries, has committed to the development of a sustainable energy policy, which identifies the need for the development of a domestic biomass fuel supply and market.

In 2007, grants for planting miscanthus and willow became available from the Ministry of Agriculture and Food BioEnergy Scheme (BES) and this has lead to a sudden and widespread increase in planting of these crops. At the same time, an increase in cultivation of oilseed rape for biodiesel has occurred. The consequences of changing land-use management, e.g. conversion from food to energy crops, on the biodiversity of agroecosystems and the services they provide remain largely unexplored [1; 2]. The impacts of energy crops may not be limited to direct effects, but there may be indirect effects due to a change in management practices. For example, a change in ploughing regime, agrochemical application and harvesting may have indirect effects on biodiversity and ecosystem services. The role of agri-environment schemes used in conjunction with energy crop cultivation may further affect biodiversity and ecosystem services. To investigate such effects will require an understanding of how the historical consequences of agricultural intensification interact with the cultivation of biomass fuel crops.

The project SIMBIOSYS (Sectoral IMpacts on BIOdiversity and ecoSYStem services) will investigate how the establishment of two model biofuel crops affects the biodiversity of Irish agroecosystems, within landscapes of varying agricultural intensity. Specifically, we will investigate how low intensity perennial crops, e.g. *Miscanthus x giganteus* (Elephant grass) and high intensity annual crops, e.g. *Brassica napus* (Oilseed rape) affect biodiversity at genetic, species, and ecosystem and landscape scales. In addition, we will examine the effects of the cultivation of these crops on ecosystem services. To date, ecosystem services have largely been analyzed separately. However, in any particular use of agricultural land there are many ecosystem services, some of which may benefit while others are reduced in value. The question that we consider here is how agricultural land might be managed to maximise benefits from multiple ecosystem services such as pollination services, biological control, carbon storage resistance to alien species invasion simultaneously. In addition, we will test methods for mitigating impacts in order to inform national policy decisions, and make recommendations for future strategic research and management.

[1] Semere T, Slater FM (2007) Biomass and Bioenergy 31: 20-29
[2] Westphal C, Steffan-Dewenter I, Tscharntke T (2003) Ecology Letters 6: 961-965

Friend or enemy - corridor or fence? Landscape context affects vertebrate - mediated almond pest reduction

Elisabeth Johanna Eilers (1,2) and Alexandra-Maria Klein (1,2)
(1) Department of Environmental Science, Policy and Management, 137 Mulford Hall
UC Berkeley, California 94720-3114, USA
(2) Agroecology, University of Göttingen, Waldweg 26, 37073 Göttingen, Germany

Ecosystem services like natural pest control are often delivered by organisms that depend on non-crop habitats. Hence, natural enemy activity is higher in complex- compared to simplified landscapes [e.g. 1]. We studied different aspects of natural pest control provided by invertebrates and vertebrates to the navel orangeworm, NOW, *Amyelois transitella,* the most important insect pest of Californian almond production. The immature insect stages are hidden inside almonds that remain on the trees after harvest, the so called "mummy nuts," that the worms use as their winter-residence.

We examined the question if deer, squirrels, wild pigs, and birds can directly decrease the number of NOW by eating worms, or indirectly decrease the incidence of NOW by feeding on nuts left over after harvest. As mammals and birds tend to be unwelcome in almond orchards because they can damage the nuts or decrease the harvest, pest control provided by vertebrates might be only a temporal service that turns into a disservice.

In this study we collected mummy nuts on 18 almond orchards in Colusa and Yolo Counties, California and opened them to determine the infestation with NOW. Furthermore we counted how many almonds were damaged or eaten by vertebrates.

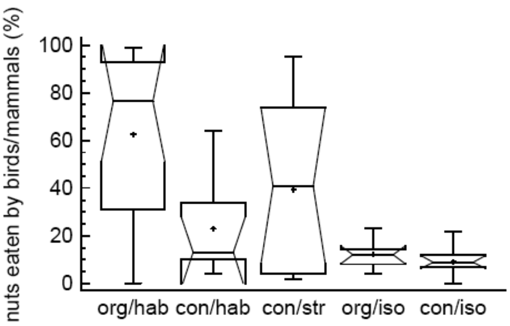

Fig. 1: Percent empty mummy nuts at orchard ground that were eaten by mammals and birds in different almond orchards. org= organic, con=conventional, hab= > 30% of natural habitat in 1km radius of the orchard, str=natural habitat strip adjacent to orchard, iso= <1% natural habitat in 1 km radius of the orchard. Kruskall-Wallis p = 0.012

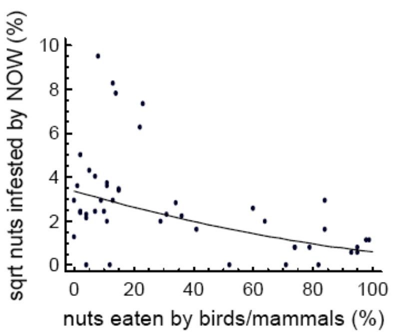

Fig. 2. Percent nuts infested by the navel orangeworm in relation to the percent empty nuts at orchard ground that were eaten by birds, squirrels, wild pigs, and deer in almond orchards differencing in management and landscape features: sqrt(x)= $(1.8345-0.106y)^2$, p = 0.006, F = 13.82, r^2 = 23.90, n = 45.

The presence of natural habitat near orchards, but not orchard management (organic versus conventional) led to a higher impact of birds and mammals on destroying over- wintering nuts, whereas this impact decreased the pest pressure of NOW. Our results indicate that vertebrates are important to provide agro - ecosystem service but new management practices are needed to use this service and to keep disservice on almond production controlled.

[1] Bianchi et al. 2006. Sustainable pest regulation in agricultural landscapes: a review on landscape composition, biodiversity and natural pest control, Proc. R. Soc. B 273, 1715–1727.

Land use impact on gastropod communities in Southern Transylvanian alluvial forests

Voichița Gheoca, Constantin Drăgulescu
"Lucian Blaga" University Sibiu, Faculty of Sciences, Department of Ecology and Environment Protection, Dr.I. Rațiu Str. 5-7, 550012, Romania

The relationship between terrestrial gastropod communities and land use intensity was studied in alluvial forests - N2000 91E0 habitat type, one of the prioritary habitats, in south Transylvania. Many of this type of forests were drasticaly reduced, consecutive land use and wood exploitation. A number of 48 habitats localized in two hydrographic basins from southern Transylvania were analyzed concerning the vegetation and gastropod communities. On the basis of phytocenologic analysis, the investigated habitats were classified in five classes considering the relative abundance of plant species indicating anthropic influence (nytrophilous, terophyte, adventive and cosmopolite species).

There were identified 98 terrestrial gastropod species. Species composition and abundance varied among habitat classes. Species number, differ considerably between degraded and natural habitats, so is the species composition.

A cluster analysis for the 48 habitats based on Jaccard similarity index, considering the presence-absence of the terrestrial gastropod species, reveald a cluster of habitats on geographic criteria, and habitat conservation degree.

Some species as *Vertigo pygmaea, Bulgarica cana, Monachoides incarnatus, Isognomostoma isognomostomos*, were found only in natural habitats, while others are ubiquist like *Helix pomatia, Helix lutescens, Fruticicola fruticum*, or their presence depend on other factors than vegetation, that is the case of soil inhabiting and hygrophylous species *Vallonia pulchella, Vitrea crystalina, Nesovitrea hammonis, Carychium minimum.*

In order to analyze the similarity between the habitats' dimension of the ecological niches, several methods are available. Some measures are considering only the species demands, criteria that represent not sufficiently objective means. The usual niches overlap measures considers also the proportional amount or size of resources state in environment, allowing to define the overlap "as the degree to which the frequency of encounter between two species is higher or lower than it would be if each species utilized each resource state in proportion to the abundance of that resource state", being not standardized.

A standardized niches overlapping or similarity index was introduced by Sarbu (2006) and used in this study, having the advantage to consider both species demands and resources availability, thus niches similarity being possible to analyze by means of hierarchical cluster analysis. Correlation analysis proves that niche width, regional frequency, occurrence and habitat differentiation of communities are significant linked, but not redundant, showing different meanings. Relations between human impact extent and communities peculiarities are discussed hereby.

Functional soil diversity and plant community performance

Natalia Ladygina (1), Joanne Bertaux (2), Frederic Henry (3), Merijn Kant (4), Robert Koller (5), Stefan Reidinger (6), Alia Rodriguez (7), Stephane Saj (8), Ilja Sonnemann (9), Christina Witt (10), Susanne Wurst (11)
(1) Lund University; Sölvegatan 37, 22362 Lund, Sweden
(2) Institute of Zoology; Darmstadt, Germany
(3) Copenhagen University; Copenhagen, Denmark
(4) Max Planck Institute for Chemical Ecology; Jena, Germany
(5) UMR INRA "Agronomie et Environnement"; Nancy, France
(6) Royal Holloway University; London, the UK
(7) Estacion Experimental del Zaidin (CSIC); Granada, Spain
(8) University of Helsinki; Jyväskylä, Finland
(9) University of Reading, Reading, the UK
(10) University of Helsinki; Lahti, Finland
(11) The Center of Terrestrial Ecology, Heteren, the Netherlands.

Functionally dissimilar soil organisms such as arbuscular mycorrhizal fungi (AMF), root herbivores and decomposers can have beneficial and detrimental effects to plant communities. There is a need for studies investigating the individual and combined effects of the functionally dissimilar soil organisms to predict their impact on plant community performance. Such predictions can be important when assessing consequences of human-induced changes in land use and climate.

We established a greenhouse microcosm experiment to investigate the individual and combined effects of functionally dissimilar soil organisms on the performance of a grassland plant community. We predicted that the performance of a plant community will depend on the interactions between AMF, root herbivores and decomposers. The following hypotheses were tested: Plant community performance depends on the type of functional group of soil organisms present: a) AMF will promote AMF-depending plant species. b) Root herbivores (nematodes and wireworms) feed preferentially on some of the plant species and therefore suppress their competitive ability. c) Decomposers (Collembola) will add the function of primary decomposition and promote plants that are strong competitors for nutrients. An increase in functional diversity (in the combined treatments) beneficially affects plant community performance. Since functionally dissimilar soil organisms promote different plant species or plant functional groups, the diversity of a plant community increases with the functional diversity in soil.

Total aboveground biomass of plants decreased in the presence of root herbivores and was also positively affected by an interaction between AMF and decomposers. Total root biomass was reduced by AMF and decomposers. Individual plant species benefited to different extents from functionally dissimilar soil organisms. Biomasses of grasses *Holcus lanatus*, *Anthoxanthum odoratum*, *Agrostis capillaries*, and *Festuca rubra* were reduced, while the biomasses of the forbs *Hypochaeris radicata* and *Plantago lanceolata* were increased by AMF. Only *H. lanatus* was positively affected by the decomposer treatment. Also, root herbivores interacting with decomposers decreased shoot biomass of legume *Lotus corniculatus.* Grass *Poa pratensis* showed no responses at all. There was no effect of functionally dissimilar soil organisms on plant species diversity. In general, all studied functional groups of soil organisms have contributed to plant community performance. Individual and combined effects of functionally dissimilar soil organisms depended on individual plant species present in the studied plant community.

Perennial crops and cutting frequency are important factors suppressing arable weeds in crop rotations

Helmut Meiss (1), Cyril Naulin (1), Rainer Waldhardt (2), Jacques Caneill (1) & Nicolas Munier-Jolain (1)

(1) Institut National de la Recherche Agronomique (INRA), UMR 1210 Biologie et Gestion des Adventices, 17 rue Sully, BP 86510, F-21065 Dijon cedex, France. Mail: helmut.meiss@dijon.inra.fr
(2) Institute of Landscape Ecology and Resource Management, Justus-Liebig-University Giessen, Germany.

Introducing perennial forage or energy crops in crop rotations may have positive effects on ecosystem services related to e.g., soil fertility, biodiversity, and also landscape structure and dynamics. For several reasons, considerable effects on plant communities - resulting in (partial) suppression of arable weeds - may be expected which would be interesting for Integrated Weed Management: In perennial crops, the soil is not tilled during several years, plants may be subjected to repeated mowing per year, and competition may be higher during large parts of the year compared to annual crops. In this context, a factorial field experiment (9 modalities * 4 reps.) was set up in Sept. 2006 to study weed community in perennial crops (*Dactylis glomerata* and *Medicago sativa*) with contrasting management regimes (sowing date, cutting frequency). An annual crop succession (winter wheat-spring barley) was included as a reference. At the beginning, soil seed bank density and diversity was low all over the experimental site and a homogeneous seed bank of 18 common annual weed species was sown in each plot. The vegetation received no herbicide application during the experiment. Weed population densities were recorded monthly on three plots per repetition (0,36m² each) and biomass was determined 6 times/year on one plot per rep.

Population density and biomass of all annual weed species decreased in 5 out of 6 modalities of perennial crops but *in*creased in the annual crops. Some perennial species appeared spontaneously in several temporary grassland plots, but not in the tilled cereal plots. Crop species was the most important factor shaping weed communities. *D. glomerata* emerged slower and was initially less competitive than *M. sativa* leading to a higher weed biomass and seed production in this crop during the first months. But once established, *D. glomerata* showed a very high potential for regrowth after cutting and formed a very competitive canopy. From the second year on, we found virtually no weeds in this crop (Fig 1). Obviously, crop-weed competition was more important than weed seed density on soil surface. Effects of cutting frequency could thus only be seen in *M. sativa* crops: The high cutting interval (5 cuts/year, **C+**) lead to signif. lower weed biomass than 3 cuts/year (**C-**), but only grassy weeds reached high plant densities (Fig. 1). Crop sowing date was only important in the first year (during crop establishment): both spring sown crops showed higher weed biomass and seed production compared to the same crops

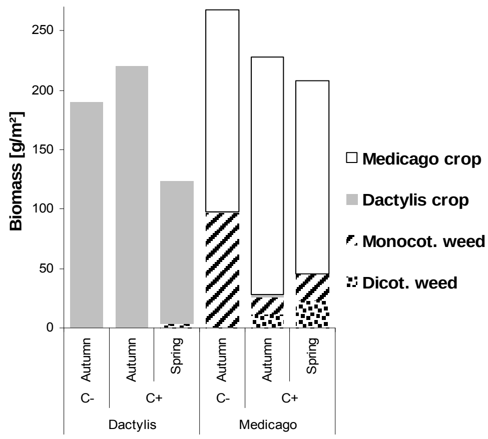

Fig. 1: Crop and weed biomass in six temporary grassland modalities (see text) in April 2008.

sown in autumn. But these differences became much smaller during the second year (Fig. 1).

Assessment of ecosystems services as a part of water and land management in the Tisza River Basin

Elena Livia Minca, Katalin Petz, Rik Leemans, Saskia Werners
Wageningen University and Research Centre, Costerweg 50, Building no. 400, 6701 BH Wageningen, The Netherlands

Providing ecosystem services – the benefits people obtain from ecosystems – is strongly dependent on the capacity of natural processes and ecosystem functioning. The inclusion of ecosystem services in spatial and policy planning is important, since the services are highly influenced by climatic conditions, water management and the institutional context. In Hungary and Romania the required scientific research for the consideration of ecosystem services in spatial planning and in the institutional context is weak. The Tisza River Basin, which is shared by these two countries, is increasingly facing the impacts of floods and droughts. In order to mitigate their effects and to sustain human well-being an integrated approach combining transboundary water and land management and the institutional context is needed. The ecosystem service perspective can provide such an approach..

This symposium aims at discussing the role of ecosystems services and their importance in two cases of the Tisza River Basin by presenting an assessment of ecosystems services in the context of land and water management schemes, policy framework and climate related extremes. The two cases are both pilot areas for new water and land management plans: (1) the Hungarian Bereg Region, where future flood-retention polder plans have been developed under the European Bereg-INTERREG Neighborhood Programme; (2) the Romanian Crişul Negru Basin where the creation of wet areas along the Crişul Negru River has been proposed by the Ministry of Environment. Fourteen ecosystem services are investigated for the following land cover types: arable land, grassland, forest, orchard, wetland, water body and urban environment. The analysis is done for the plot, landscape and watershed spatial scales.

In this symposium a specific framework will be presented focusing on the performance of ecosystem services and the factors that change it. They are: state of ecosystems, weather extremes, recognition, potential, policy measures and water management plans. Firstly, the link between ecosystems services and water and land management will be discussed. Secondly, the expression of ecosystem services in relevant European and national policy acts will be pointed out. The approach follows the similarities and differences between the two countries. Our contribution to the symposium will highlight the importance of ecosystem services and their consideration, both related to the policy context, weather extremes and water management plans in a transboundary context. The discussion will focus on how an integrated ecosystem services assessment can contribute to decision making and planning.

Weed species diversity, weed control and soil biological activity in organic and conventional vineyards

Anna Nikolaidou (1), Athina Pavlatou-Ve (2), Sofia Kostopoulou (2), Andreas Mamolos (1) & Kiriaki Kalburtji (1)
(1) Aristotle University of Thessaloniki, Faculty of Agriculture, Laboratory of Ecology & Environmental Protection; 541 24 Thessaloniki, Greece
(2) Aristotle University of Thessaloniki, Faculty of Agriculture, Laboratory of Soil Science; 541 24 Thessaloniki, Greece

The effects of organic and conventional practices on weed species diversity, weed control, soil biological activity and nutrition of grapevine (*Vitis vinifera* L.) were studied in four organic and four conventional commercial wine grape vineyards located in the area of Thessaloniki, northern Greece. Organic management practices included the addition of cattle manure and the use of tillage for weed control. Conventional management practices included the addition of synthetic fertilizers (15-12-10 and NH_4NO_3) and the application of Glyphosate for weed control. Weed species diversity was estimated on weed biomass collected in March 2004, by using a number of indices (e.g. first order Jackknife plant richness estimator, Margalef' s index of diversity and Shannon- Weiner index of evenness). Farming systems' efficacy on weed control was examined by estimation of total weed biomass. Soil chemical properties (organic matter, total N and NO_3^-) and biological properties (microbial respiration rate) were measured on soil samples collected in March 2004. Nutrient concentrations of grapevine petioles and soil chemical properties (e.g. pH, total N, Olsen P and exchangeable cations K^+, Na^+, Ca^{++} and Mg^{++}) were measured on samples collected at full bloom (May 2004).

The first order Jackknife plant richness estimator was significantly higher in organic (14.77 ± 0.21) than in conventional (13.60 ± 0.31) vineyards. In May 2004, soil NO_3^- and water-soluble ions NO_3^-, K^+ and Mg^{++} were significantly higher in the conventional (280.1 ± 32.3 mg NO_3^- kg^{-1}, 0.12 ± 0.04 me NO_3^- $100g^{-1}$, 0.039 ± 0.007 me K^+ $100g^{-1}$ and 0.21 ± 0.02 me Mg^{++} $100g^{-1}$) than in the organic (138.9 ± 15.4 mg NO_3^- kg^{-1}, 0.03 ± 0.01 me NO_3^- $100g^{-1}$, 0.020 ± 0.004 me K^+ $100g^{-1}$ and 0.13 ± 0.02 me Mg^{++} $100g^{-1}$) farming system. Grapevine petiole P, K and Zn were significantly higher in organic (6.0 ± 0.6 mg total P g^{-1}, 26.4 ± 2.1 mg total K g^{-1} and 62.4 ± 3.8 mg total Zn kg^{-1}) than in conventional (4.1 ± 0.4 mg total P g^{-1}, 18.8 ± 1.6 mg total K g^{-1} and 42.1 ± 4.0 mg total Zn kg^{-1}) vineyards. Both farming systems were effective in weed control, however organic farming system enhanced weed species diversity.

Analysis of landscape characteristics and farmland birds in Southern Sweden

Persson Anna Rundlöf Maj, Dittrich Ralf and Smith Henrik G.
Lund University, Animal Ecology; Ecology Building, Se-223 62 Lund, Sweden.

Agricultural development and intensification has led to homogenisation of the landscape at many spatial levels; from common agricultural policies within the EU to technical development leading to larger and cleaner fields, free from weeds and with homogeneous moisture due to drainage [1]. At the same time extensively managed areas run the risk of being “under managed” or completely abandoned. Landscape structure and heterogeneity is thus lost via two seemingly contrasting processes. The Swedish National Bird Monitoring programme reveal contrasting trends among birds associated to farmland [2]. Many songbirds show constant numbers over time, while other species have declined dramatically. Several studies have shown farmland bird species to be associated with separate landscape elements, for example hedges, or type of land use [3, 5].

There are two aims of this project: 1. To study the relationship between spatial structure (e.g. landscape heterogeneity) and intensity of land use. 2. To investigate how these two factors affect abundance of farmland birds. We analysed landscape data in 155 1km^2 squares distributed over the region of Skåne (Scania), southernmost Sweden. We used spatially explicit digital data on land use, digitised aerial photographs, field surveys of both landscape elements and birds and agricultural statistics. Data was processed in ArcGis and SAS. A preliminary PCA suggests that there are indeed two axes, where one can be interpreted as describing landscape structure while the other is more connected to the intensity of land use. Variables such as the level soil nitrogen, yield of spring barley and proportion arable land score highly on PC1 (land use intensity), while e.g. amount semi-natural habitats, land use diversity and structural indexes like Contagion (Fragstats) [4] score highly on PC2 (landscape structure). We believe that it is important to consider both of these two landscape level factors when trying to explain patterns of biodiversity change in agricultural landscapes. The analysis of the bird survey data, in relation to the above mentioned landscape factors, will be done shortly and the results presented.

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Effects of bioenergy production on European wetland restoration options

Christine Schleupner & Uwe A. Schneider
Hamburg University, Research Unit Sustainability and Global Change, Bundesstr. 55, Hamburg,Germany; christine.schleupner@zmaw.de

Wetlands constitute valuable ecological resources. Their existence is driven by site specific natural conditions and the economic environment. This study integrates both aspects by linking a GIS-based wetland model with the European Forest and Agricultural Sector Optimization Model (EUFASOM). EUFASOM is a partial equilibrium model which studies simultaneously synergies and tradeoffs between biodiversity conservation efforts, greenhouse gas mitigation options including carbon sinks and bioenergy, as well as traditional agriculture and forestry markets. Conservationists are concerned that promotion of bioenergy plantations in the context of climate change mitigation policies could further threaten nature reserves.

This study evaluates biophysical and economic potentials to preserve existing habitats, to restore formerly native habitats, and to create non-native managed habitats with respect to freshwater wetlands of the EU-25 states. Through a GIS-based model the distribution of existing wetland habitats and potential wetland restoration sites is visualised. The model distinguishes five wetland types and 6 structures. Spatially explicit wetland distribution data are aggregated to country level and integrated into EUFASOM. For different policy scenarios, the optimization model computes the corresponding economic potential of wetlands, its effects on agricultural and forestry markets, and environmental impacts of bioenergy plantations.

Large wetland areas impact food production, consumption, and market prices. Higher food prices rise the opportunity costs of wetlands. If these cost changes are ignored, the resulting marginal cost predictions can be substantially underestimated. Similarly, adding nationally obtained cost estimates understates the true cost of EU-wide preservation incentives. Existing European wetlands are relatively well protected through EU-policy measures. However, these areas may need to be extended to realize the ambitious political targets related to biodiversity protection.

Bioenergy targets have enormous effects on conservation planning and nature conservation. An enforcement to achieve the EU-bioenergy target, meaning to produce about 300 mio wet tons of biomass per year, would lead to less wetland restoration areas at very high incentives, but even to no additional wetlands, respectively conservation areas, than the existing at incentives up to 1000 Euro per hectare. This also reflects in regional and country-specific analyses.

Regional and country-specific differences in wetland potentials exist as well. The wetlands are not evenly distributed due to their geo-ecological and spatial relationships but also because of economic aspects like land costs, for example.

The presented study helps to find the socially optimal balance between alternative wetland uses by integrating biological benefits – in this case wetlands - and economic opportunities – here agriculture and forestry. Spatial data provide a possibility to build the interface between economic and ecologic models.

The effect of various densities on the trend of growth, yield, vield components of three soybean cultivars (*Glycine max (L.)Merr*.)

Keyvan Shamsi, Sohil Kobraee and Hamid Mehrpanah
Islamic Azad Universit, Department of Agronomy and plant breeding, Baghenaistreet, Kermanshah, Iran,
email : shams 2 _k@yahoo.com

For the purpose of studying the effect of different densities on the trend of growth, yield and its components of three varieties of soybean in climatic conditions of Kermanshah, an experiment on search field; Mahidasht, Kermanshah, dependent to agriculture research center, was performed in 2002.This factorial experiment of research was carried out four replication and in the form of the random complete blocks design. Varieties factor were placed in the blocks at 3 levels including Williams, Zan, and Clark varieties and density factors at 3 levels including plant were placed on 3,5,7cm rows in the blocks. According to the results, among various numbers, the greatest one of dry weight of the plant was allocated to Clarks variety. Comparison of dry material trend at different densities also indicated that with increasing density, dry weight of area organs will be decreased. On the other hand, comparison of the changes trend of the leaf area index in different densities showed that this index will be increased with increasing density; therefore, the greatest degree of it was observed at D1 density . In accordance with density increase, the crop growth rate slightly increased, but then with additional increase of density the CGR was decreased so that its maximum was observed at D2 density. The results of comparing among the changes of relative growth rate showed that Williams variety and D3 density possessed the highest degree of RGR of all varieties and densities, respectively. In this study density increase caused the height of plant; the interface of the first sub branch from soil surface ; the length of inter node ; the number of nodes in main branch ; the number of grain in pod in plant ; grain yield at level unit ; and biological yield performance to increase , on one hand , and the number of sub branch, node, pod, grain in plant and sub branch; plus dry weight of grain In plant and sub branch to decrease on the other hand. The percentages of protein and oil; harvest index ;100grains weight on the main and sub branch and plant; the number of grain in pod of main and sub branch were not all affected by plant density. Density increase led the number of pod in node in plant to slightly increase, but more than that made this component of yield be decreased. The largest number of node and pod in node of the plant; 100 grains weight in plant and dry weight in sub branch belonged to Clark variety, but the greatest number of grain in pod of plant belonged to Williams variety. In general, most of grain yield at level unit allocated to treatment V1D1.

More biodiversity at less cost: an integrated ecological-economic approach to preservation of small landscape elements

Annika Söderman (1), Therese Irminger Street (1), Mark Brady (2), Karin Hall (3), Katarina Hedlund (1) (4), Honor Prentice (4), Henrik Smith (1) (4) & Ola Olsson (4)
(1) Lund University, Department of Environmental Science; Sölvegatan 37, 22362 Lund, Sweden
(2) Swedish Institute for Food and Agricultural Economics; Scheelevägen 15 D, 22363 Lund, Sweden
(3) Lund University, Department of Physical Geography and Ecosystem Analysis; Sölvegatan 12, 22362 Lund, Sweden
(4) Lund University, Department of Ecology; Sölvegatan 37, 22362 Lund, Sweden

In the agricultural landscape habitat for numerous species has become increasingly scarce due to the intensification of agriculture. In these areas small landscape fragments, such as stonewalls, field islets and ditches, can be very important in maintaining biodiversity and ecosystem services. They increase landscape heterogeneity and are often the only remnants of the original habitat and thereby constitute the only suitable habitat for some species. Further more, they can provide necessary resources such as food and nesting sites as well as enable dispersal by acting as corridors. They also form part of our cultural heritage.

In order to preserve this cultural heritage and maintain biodiversity, agri-environmental support is paid to landowners who follow specified management regimes. The effect of the prescribed management has not been properly evaluated and hence the cost-effectiveness of the current support system in terms of biodiversity and ecosystem services is not well known. One of the main objectives of this study is to develop an integrated ecological-economic model that can be used to determine the cost-effectiveness of current and future conservation policies. As a first step towards developing such a model the importance of small biotopes to maintain biodiversity and ecosystem services will be evaluated.

Focus will be on insects performing ecosystem services in the form of pollination and natural predation on crop pests and on the diversity of vascular plants. The services provided by these insects are important not only to farming but also vital for many wild plants. The insects in turn depend on the availability of resources provided by plants. Also, many species in these groups are threatened and of conservation concern.

The study will take place in the region of Skåne in southern Sweden where the agricultural land has been classified into three types according to level of landscape complexity. The low-complexity area is characterised by intensive agriculture, with large fields and low percentage of non-arable land such as pastures. The high-complexity area on the other hand has smaller field sizes and more pastures and woodland. The project will start this summer (2008) by estimating the diversity of vascular plants, pollinators and natural enemies in linear elements in the different types of agricultural land. Elements in each region will be studied with respect to their location in the landscape and their management. Preliminary results will be presented.

Commercial bumblebees – threat for wild populations

Hajnalka Szentgyörgyi, Elżbieta Rożej, Marta Wantuch, Dawid Moroń, Michal Woyciechowski
Jagiellonian University, Institute of Environmental Sciences, ul. Gronostajowa 7, 30-387 Kraków, Poland

In the last two decades there has been increased interest in bumblebees as pollinators for greenhouse crops such as tomato, sweet pepper and cucumber. Effectiveness of these pollinators that contributes to economic profits caused that nowadays commercially reared bumblebees have world-wide distribution and occur at high densities in greenhouse cultivars. That creates new threats for native populations, as commercially-produced bumblebees crowded in greenhouses can act as ideal reservoirs of parasites while individuals escaping, as a vector that transmits parasites to natural populations. Lately, attention has been focused mostly on the common a microsporidian parasite of the bumblebee *Nosema bombi*. Infection with *N. bombi* gives symptoms ranging from decrease of worker pollination performance and queen mating ability, to increased mortality and death of colonies.

The aim of this study was to quantify the impact of commercial bumblebees on the level of parasitation among wild populations neighboring greenhouses.

We have checked the presence and abundance of *N. bombi*, in bumblebees at three locations in southern Poland – in three greenhouses, at sites in the vicinity of these greenhouses, and at three sites distant from the greenhouses. Additionally, we have also sampled nests received from the two largest suppliers. Our results show that bumblebees are sold with a relatively high level of infection and this initially high level is rising, while nests are exposed in greenhouses. The highest level of infection was observed in greenhouse populations which can therefore serve as a reservoir of microsporidian pathogens. This is clearly reflected in higher parasitation levels of near greenhouse populations, which were shown to be influenced by individuals escaping from these greenhouses, compared to sites distant from them. Nevertheless, further studies on a larger sample size are needed to confirm the detrimental effects of domestic bumblebees on native species.

Remaining rare plant species in vineyards at the Elbe valley near Dresden / Meißen under conditions of "industrialized agriculture", also on very small urban areas

Siegmar Thomas
Dresden University of Technology, Institute of Landscape Architecture. Germany, Saxony,D-01062 Dresden

The contribution describes former species-rich vineyard areas near Dresden / Meißen. Since the Middle Ages were used predominantly the right-hand Elbe river slopes exposed to south and west between Pillnitz south of Dresden and Seußlitz north of Meißen (50 km). In the old vineyards ("Weingärten") the wine rows were planted parallel to contour lines. On extreme steep slopes (slope inclination more than 15 to 20° up to more than 45°) the well-known stone walls were constructed since 4 centuries forming narrow vineyard terraces. The region harbored a large variety of – now – rare, often mediterranean, species. A plant list is given following Hardtke and Ihl (2000) and Schulz (1999), containing indigenous, archaeophyte and neophyte species, now extremely rare and disappeared up to "only" endangered ones (Red list Saxony).

These former slope vineyards are now managed as urban "industrialized agriculture" areas, mostly by nearly 3650 hobby-mini-winegrowers in the conurbation "Upper Elbe". The old contour-line-following wine-rows were mostly replaced by such ones following the slope curves / altitude gradients; if at all possible old terrace walls were removed (except on very steep slopes with large terrace walls many above the others). The "modern" urban "industrialized mini-plots viticulture" is in practice also in the immediate vicinity to living houses and residential areas without any protective distance zones or shelterbelts. The management is now done by slope-down and -up tillage with cable winch machines or if at all possible with special tractors, very often and strongly intensified. This is often causing enormous "desert storms", wind and water erosion. Also the spread of mineral fertilizers and the spread of pesticides are done if at all possible with the most powerful engines (developed for large agricultural areas far away from settlements / living houses) – here by enormous pesticide emission and drifting into living areas (the largest amounts of pesticides were used in vineyards, compared to other agricultural fields). The biodiversity is strongly reduced. Only some common pasture grasses and herb species occur sometimes shortly. On rare places some species, e.g. *Ornithogalum nutans* L. with bulbs deeply in ground, resists frequent tillage with heavy technical equipments.

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Ex-ante analysis of an agroforestry management option in Southern-Ecuador

Frank von Walter (1), Jan Barkmann (1) & Roland Olschewski (2)
(1) Georg-August-Universität Göttingen, Department of Agricultural Economics and Rural Development, Platz der Göttinger Sieben 5, Germany
(2) Economics and Social Sciences Unit Swiss Federal Research Institute WSL; Switzerland

In Southern Ecuador there is an accelerated land use change from fragmented forest to crop and cattle farming. This is also true for “Biosphere Reserve Podocarpus - el Cóndor” (BRPC) in the provinces of Loja and Zamora-Chinchipe, where the principal economic activity is livestock farming in the west of the park supplemented by timber extraction in the eastern part. One option to mitigate the negative effects of cattle farming is the introduction of agroforestry management systems (AFMS).

In AFMS crop plants are planted along the boarders or within differently used land (e.g., pastures or natural forest). The crop plants can have a beneficial effect on the land (e.g., leguminous plants improve the nitrogen status of the soil), enhance the land-use (e.g., shade trees for animals on pastures), provide an extra source of income (e.g., fodder or marketable products) and enhance the biodiversity.

However, financial net benefits from AFMS can only be reaped after an establishment period of, at times several years. We exemplify this by exploring AFMS with Tara (*Caesalpinia spinosa*; Fabaceae) as the tree component

Tara is a leguminous shrub or small tree. It reaches about 5 m in height, it is common in the Andes and grows in altitudes up to 2800 m. Adult trees yield 20 – 40 kg of fruit. Commercially Tara seeds are used for dying, tanning and as a food additive (E 417 - Tara Gum). Successful planting projects have already been conducted in Northern Peru; a Tara planting project is on its way in other parts of the Loja province.

Results from planting projects will help to refine the values for expected yields in the BRPC region. First calculations show, that the expected net benefits from Tara are considerable for several interest rates (5 % to 8 %). After an establishment period of 5 years Tara seeds form a constant source of income. The positive effect holds true for a range of Tara-tree densities (200 to 600 plants/ ha) and expected market prices (0.1 US $/ kg to 0.5 US $/ kg). Even with tentative assumptions on market prices and conservative interest rates

(8 %), Tara seeds are far more profitable than Alnus-Plantations (the commonly proposed sustainable land-use) or cattle ranching (the current most profitable land-use type). These findings underline the attractiveness of this land-use option, which is at the same time profitable and sustainable

Tara has a high economic potential. In Peru alone, the production has increased almost ten-fold in the last six years. However, for the BRPC region there is a considerable risk component involved. Firstly, little is known about the performance of the Tara-plant under the regional environmental conditions. Secondly, there is a lack of knowledge among the local smallholders towards this agroforestry innovation.

We’ll present a production model, with which we can do an economic ex-ante analysis and can give recommendations for funding programs as well as contract and credit design.

Major Environmental Research Projects – Conception, System Architecture and Functionality of a Central Information System

Cornelia Weist & Claus Mückschel
University of Giessen, Institute of Biometry and Population Genetics;
Heinrich-Buff-Ring 26-32, 35392 Giessen, Germany

The setup and successful maintenance of a central data management in major research projects like the Sonderforschungsbereich (SFB) 299, the Collaborative Research Centre 299 "Land Use Options for Peripheral Regions" supported by the German Research Foundation incorporates challenges in profession, content and technology.

The data management has to ensure that all participating researchers of the project are able to access existing data in a knowledge-based and problem-oriented way. Moreover its role is to optimize data transfer amongst the subprojects. Primarily this includes provision of basic and metadata as well as securing of their long-term availability and accurate interpretability. Furthermore it needs to supply tools for data input, editing and enquiry, alongside services for data storage and backup, for support of processing and combination of available information as well as extended facilities for presentation and analysis.

An essential approach to fulfil the tasks contemplated above is the setup of a central information system. It has to be capable to represent the manifold data of all subprojects in a standardized format and make them broadly available. This is important for revelation synergies in succession of joining heterogeneous data sets crossing graduations as regards space, content and time.

The web-based SFB-information system mainly deploys Open Source technologies. It is structured as distributed client-server-architecture and comprises i.e. a PostGIS data base, an UMN Mapserver and the client suite Mapbender for visualization and analysis of spatial data. Qualities like system openness and scalability, user friendliness, support of OGC-compatible services as well as tools for simple data analysis without expertise of desktop-GIS have been of high significance during the development process of the application and selection of appropriate software products.

The long duration of Collaborative Research Centres along with rapid progress in information technology (IT) leads to particular requirements regarding utilized system architecture. Designed IT systems have to be adapted repeatedly due to steadily changing demands and focal points concerning all supported scientific disciplines. Consequently this leads to a high dynamic within the data management.

This article reports about conception, architecture, and range of functionalities of the SFB-information system which has been developed during a runtime of 11 years by the subproject "Data and Information Management".

Identification and sustainable use of ecosystem services

4.3. Biodiversity and ecosystem functioning studies at varying plant species richness

Andy Hector, Stefan Scheu, Wolfgang Weisser, Helge Bruelheide

Oral presentations

Measuring, modeling and mapping pollination services in real landscapes

Claire Kremen
(1) Department of Environmental Science, Policy and Management, 137 Mulford Hall
UC Berkeley, California 94720-3114, USA

Honey bees have become an essential farming input for modern intensive cultivation of numerous crops – yet the number of managed colonies has been in decline for decades, a problem exacerbated by recent sudden declines (Colony Collapse Disorder). Under what conditions can native bee communities fill the gap? I examine this question in two contrasting farming landscapes. In California, only farms near natural habitat had bee communities sufficiently diverse and abundant to provide complete pollination services to watermelon, a highly pollinator-dependent crop. In contrast, most farms in a New Jersey landscape had diverse bee communities capable of providing complete pollination. In New Jersey, agricultural landscapes are a heterogeneous mix of natural habitat patches, old fields, organic and conventional farms. Thus, in New Jersey, whether bees are nesting on a farm, in natural habitat patches or in old fields, smaller farm sizes and heterogeneous landscapes lessen the distance between nesting and feeding sites, so that bees can find ample forage resources within foraging range of the nest anywhere in the landscape. In contrast, in California, where the landscape is dominated by large, intensively-managed farms that contain few floral resources, floral resource distribution may limit nest site selection and hence bee distributions. Bee species may not find enough forage resources in the intensively managed landscape to nest there, accounting for the low diversity communities found in such landscapes. I present a new spatially-explicit model to further explore these differences, based on the spatial distribution of floral and nesting resources to predict bee abundances and pollination services of bees in different nesting and foraging guilds.

Aphid-parasitoid interactions change with declining plant diversity

Jana S.Petermann (1), Christine B. Müller (1), Wolfgang W. Weisser (2) &Bernhard Schmid (1)
(1) University of Zürich, Institute of Environmental Sciences; Winterthurer Str. 190, 8057 Zürich, Switzerland
(2) Friedrich-Schiller-University, Institute of Ecology; Dornburgerstr. 159, 07743 Jena, Germany

The positive relationship between plant diversity and primary productivity is already well established. However, few studies have examined effects of declining plant species richness on ecosystem functioning at higher trophic levels. Especially changes in multi-level interactions in response to manipulated plant diversity have rarely been investigated.

We studied trophic interactions between aphids and their parasitoid assemblage at different plant diversity levels in a large biodiversity experiment (The Jena Experiment). This long-term field experiment contains special plots with replicated communities of 1–9 dominant grassland plant species. Plant biomass and cover were measured in spring and autumn 2006. Within the communities, we found seven abundant aphid species on four host plants (two grasses, one legume and one tall herb) and recorded aphid numbers regularly during the whole field season. Parasitized aphids, which turn into immobile "mummies", were collected to determine the hatching parasitoids and secondary parasitoids. Because one aphid individual can at most be parasitized by one parasitoid individual, we could directly quantify the trophic interaction. The body mass of the two most abundant parasitoid species was determined and used as a fitness measure.

We found that aphid density decreased with increasing plant diversity. This was probably due to lower host plant biomass in more diverse communities. The decline in aphid abundance was paralleled by an even stronger decrease in parasitoid density. Thus, parasitism rate (number of parasitized aphids per total aphids) showed a tendency to decline with increasing plant diversity. Parasitoids appeared to have difficulties in locating their aphid hosts at very low densities. Neither aphid nor parasitoid abundance was enhanced by the presence of legumes in the experimental plant community. This was surprising because legume presence was the strongest predictor of a range of other ecosystem functions in our and in other grassland experiments. However, we did find a positive effect of legume presence on the fitness of primary parasitoids, indicating that their aphid hosts benefited from feeding on plants “fertilised” by neighbouring legumes.

In summary, we demonstrate that effects of declining plant species richness extend to higher trophic levels, both directly and indirectly, and thus can shape trophic interactions across the entire ecosystem.

Community-scale effects of climate warming on experimental grasslands of different species richness

Hans J De Boeck, Catherine MHM Lemmens, Costanza Zavalloni, Birgit Gielen, Reinhart Ceulemans & Ivan Nijs
Research Group of Plant and Vegetation Ecology, Department of Biology, Universiteit Antwerpen (Campus Drie Eiken), Universiteitsplein 1, B-2610 Wilrijk, Belgium

The rapid rise in greenhouse gases, a consequence of global industrialization and land use changes, has caused the earth to warm substantially during the past century. Global warming is projected to accelerate in the 21st century, with projected increases of 1.8 to 4.0 °C by 2100 ("best estimates"). These projections of a future warmer climate have stimulated studies on the response of terrestrial ecosystems to this global change. Experiments have likewise addressed the importance of biodiversity for ecosystem functioning, as the number of species is decreasing rapidly worldwide. Little knowledge exists, however, on the interplay between warming and species richness (S). This is of importance as the responses to single changes are not necessarily additive.

For three years, we grew experimental plant communities containing one, three or nine grassland species in 12 sunlit, climate-controlled chambers in Wilrijk, Belgium. Half of these chambers were exposed to ambient air temperatures (unheated), while the other half were warmed by 3 °C (heated). Equal amounts of water were added to heated and unheated communities, so that warming would imply drier soils if evapotranspiration was higher. In this study, we focused on processes at the community scale. We assessed biomass production above- and belowground, water relations and CO_2 fluxes, and attempted to identify how these were interrelated.

The three-year experiment showed that warming lowered biomass production both above- and belowground, by 29% and 25%, respectively, on average over all periods and S levels. This was caused by increased heat and drought stress, especially during summer. In reaction to these abiotic stresses, community photosynthesis decreased, while the proportionate respiration (per gram of biomass) was increased, and evapotranspiration remained largely unchanged. This resulted in less efficient water use, which was reflected by lower primary production in heated communities. Complementarity effects, likely mostly through both increased aboveground spatial complementarity and facilitative effects of legumes, led to higher photosynthetic rates, more efficient water use, and ultimately higher shoot and root biomass in multi-species communities, regardless of the induced warming. The effect of warming differed between S levels, with the smallest heating-induced changes found in monocultures, and the largest changes in nine-species communities. This may be attributed to more intense interspecific competition for resources under conditions of high abiotic stress. Our results suggest that warming and the associated soil drying could reduce primary production in many temperate grasslands, and that such adverse effects of warming may not be mitigated by efforts to maintain or increase species richness.

Diversity enhances community recovery after a natural drought

Jasper van Ruijven & Frank Berendse
Wageningen University, Nature Conservation and Plant Ecology Group, PO Box 47, 6700 AA Wageningen, the Netherlands

There is growing concern that the current loss of biodiversity may negatively affect ecosystem functioning and stability. Although it has been shown that species loss may reduce biomass production [1] and increase temporal variability [2], experimental evidence that species loss affects ecosystem resistance (the ability to withstand perturbation) and resilience (recovery from perturbation) is very limited. Following the insurance hypothesis, both resistance and resilience should increase with diversity because a greater number of species can show a greater range of responses to environmental fluctuations, which increases the likelihood that some species will compensate for others [3]. However, earlier work has shown that the response to perturbation depends on the relationship between the response variable (aboveground biomass) and diversity. If biomass increases with diversity, resistance is likely to be higher at low diversity, simply because the reduction of biomass due to perturbation is limited by the lower amount of biomass [4]. This phenomenon led a recent study to conclude that biomass, rather than diversity, determines the susceptibility to drought [5].

Here, we use the response of experimental plant communities - that differ in diversity - to a natural drought to disentangle the effects of diversity and biomass on resistance and resilience. Similar to earlier experimental work [4], resistance decreased with diversity, but this pattern was highly dependent upon pre-drought biomass (Fig. 1a). When corrected for biomass, the relationship between diversity and resistance was neutral: at each level of diversity, biomass production was reduced by approximately 30%. In contrast, recovery of biomass production after drought increased with diversity and was independent of pre-drought biomass (Fig. 1b). As a consequence, the ratio of pre- and post-drought biomass was similar at each level of diversity. Analysis of individual species confirmed the biomass-dependence of resistance. In contrast to the community, most species showed no relationship between diversity and recovery, but the recovery of one species (the grass *Anthoxanthum odoratum*) strongly increased with diversity, contributing greatly to the positive relationship between diversity and the ability of the community to recover from perturbation.

The conclusion that can be drawn from these results is two-fold: on the one hand, they confirm findings from earlier work [4, 5] that resistance is mainly driven by pre-drought performance rather than by diversity, thus reje

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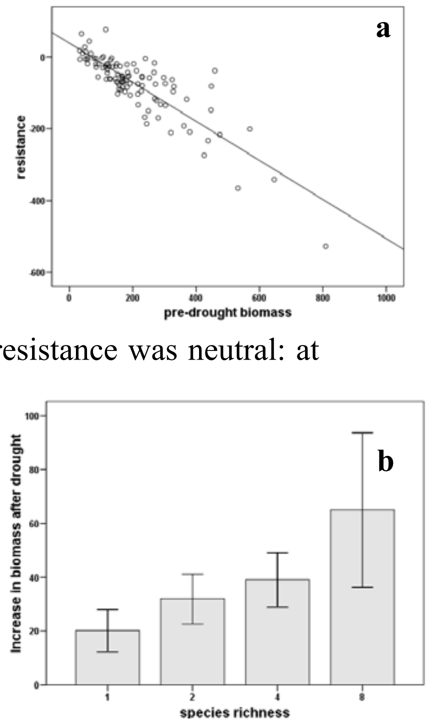

Figure 3 a) Resistance strongly decreased with the amount of biomass produced before the drought ($F_{1,98}$ = 188; $P < 0.0001$; $r^2 = .65$). In contrast, (b) recovery after drought increased with diversity ($F_{1,99} = 5$; $P < 0.05$) but it was independent of pre-drought biomass.

Does herbivory influence the nitrogen and phosphorus dynamics in throughfall and soil solution?

Anika K. Richter (1), Yvonne Oelmann (1), Franz Bender (1), Stephan Rosenkranz (1) Christoph Scherber (2), Wolfgang W. Weisser (3), Nico Eisenhauer (4), Stefan Scheu (4) and Wolfgang Wilcke (1)
(1) Johannes Gutenberg-University Mainz, Geographic Institute; Johann-Joachim-Becher-Weg 21, 55128 Mainz, Germany
(2) Georg August-University Göttingen, Agroecology; Waldweg 26, 37073 Göttingen, Germany
(3) University Jena, Institute of Ecology; Dornburger Str. 159, 07743 Jena, Germany
(4) TU Darmstadt, Biology; Schnittspahnstr. 3, 64287 Darmstadt, Germany

Increasing plant species diversity in grassland results in more diverse interactions among the involved organisms at different trophic levels possibly influencing nutrient cycles. Up to now, little is known about the role of organisms at higher trophic levels such as herbivores for N and P cycles. Herbivores might influence N and P cycling because of increased N and P throughfall fluxes by destruction of plant surfaces and excrements. We examined the response of N and P fluxes (throughfall and soil solution) to herbivory in experimental grassland communities of differing plant species diversity in the long term "Jena Experiment" in spring and autumn of 2003 and 2004. Furthermore, in an laboratory incubation experiment, we tested the effect of addition of distilled water (Control), nutrient solution containing N and P but not C (NuS), and throughfall (TF) on the microbial release of CO_2, and release/retention of N and P species in soil.

In the field, we found a positive correlation between herbivory and dissolved organic nitrogen (DON) and phosphate. It was shown that already up to 3% leaf area eaten by herbivores contributes by about 40 % of total DON and phosphate throughfall fluxes, suggesting that herbivory accelerated N and P cycles. By contrast, herbivory was negatively correlated with phosphate concentrations in soil solution ($R^2 = 0.27$). In the incubation experiment, TF addition increased nitrate and phosphate retention in soil compared to the Control and NuS treatment. Nitrate retention was significantly related to microbial CO_2 release ($R^2 = 0.64$). Phosphate retention was, however, not correlated with CO_2 release suggesting that precipitation as calcium phosphates was the main driving mechanism. As dissolved nutrients in throughfall are readily bioavailable, temporarily increased N and P concentrations in soil solution by the addition of nutrient-enhanced throughfall due to herbivory lead to a stimulation of the microbial community which results in increased immobilization of N and P. However, throughfall addition did not increase CO_2-C release as a direct measure of microbial activity. Further experiments are needed to elucidate the effect of throughfall addition on microbial metabolism, particularly the respiration to assimilation ratio.

There is evidence that herbivory contributes to a faster recycling of N and P from plants to soil solution. In soil, these nutrients disappear from the dissolved phase. However, further research is necessary to answer the question whether N and P are fixed in the soil solid phase, taken up by plants or immobilized by microorganisms.

Determination of root botanical composition using near-infrared reflectance spectroscopy (NIRS)

Catherine Roumet, Nicolas Gross, Damien Landais, Richard Joffre
Centre d'Ecologie Fonctionnelle et Evolutive, CNRS, UMR 5175, 1919 route de Mende, 34293 Montpellier Cedex 5, France

Understanding competitive interactions in plant communities and how they are affected by changing resources is greatly limited by our ability to identify and quantify roots belonging to different species. The near-infrared reflectance spectroscopy (NIRS) offers interesting perspectives in that domain: the botanical composition of artificial root mixtures is indeed well predicted by NIRS method [1]. NIRS discriminated root species with contrasted root traits (species from different families) but also roots of species with close characteristics (species within perennial grasses). Within species root systems are extremely plastic [2]; in response to environmental conditions, their chemical and morphological traits are affected and might affect the spectral characteristics of each species. We tested whether soil nutrient fertility and mixture complexity affected spectral characteristics and whether NIRS calibrations should be conducted for each set of environmental conditions or for the whole set of samples in order to include a large range of variability.

Six perennial grass species were grown individually under low (LN) and high (HN) nutrient conditions. Artificial three (3-sp) and six (6-sp)-species root mixtures were prepared by mixing roots grown either at low or high nutrient level. Calibration equations were developed i) for each nutrient treatment, ii) for each mixture complexity treatment, iii) by combining the two fertility treatments (LN+HN) or iv) by combining the two levels of mixture complexity (3-sp + 6-sp).

NIRS well discriminated LN and HN root mixtures as well as 3- species from 6-species mixtures. Botanical composition of root mixtures was predicted well for all the species considered. The accuracy varied according to the calibration used. For nutrient effect, the best predictions for all species and N treatments were obtained with the LN + HN calibration equation. Correlation coefficients between predicted and actual root proportions ranged from 0.98 to 0.99. For mixture complexity treatment, 3-sp mixtures are better predicted by 3-sp and 3-sp +6-sp calibrations(r = 0.99 and 0.97 respectively) than by 6-sp calibration (r = 0.94). Similar trend was obtained for prediction of 6-sp mixtures.

These results suggested that a common calibration including a wide range of variability provided promising potential for predicting the root botanical composition of mixtures grown in contrasted conditions.

[1] Roumet et al. 2007. Quantifying species composition in root mixtures using two methods: NIR spectroscopy and plant wax markers; *New Phytologist,* 170: 631-638.
[2] Hodge A. 2004. The plastic plant: root responses to heterogeneous supplies of nutrients. *New Phytologist* 162, 9-24.

Effects of extreme weather events on plant performance and ecosystem functions - the EVENT Experiment

Anke Jentsch (1,2), Juergen Kreyling (2), Carl Beierkuhnlein (2)
(1) Helmholtz Centre for Environmental Research – UFZ, Permoserstr. 15, D-04318 Leipzig
(2) University of Bayreuth, D-95440 Bayreuth, Germany

Intensification of weather extremes is currently emerging as one of the most important facets of climate change. Research on extreme events has increased in recent years and now amounts to a fifth of the experimental climate change studies published. Numerous examples ranging from microbiology and soil science to biogeography demonstrate how extreme weather events can accelerate shifts of species compositions and distributions, thereby facilitating changes in ecosystem functioning and services.

Here, we present results of the EVENT-experiment (Bayreuth), in which planted grassland and heath communities were annually exposed to a single drought event, a heavy rainfall event, or recurrent freeze-thaw cycles. The magnitude of manipulations imitated the local 100-year weather extreme according to extreme value statistics.

Our results reveal, for example: Overall productivity (ANPP) of both plant communities remained stable in face of drought, despite significant effects on tissue die-back and competitive interactions among species. Drought and heavy rain events caused phenological shifts in plants of the same magnitude as one decade of gradual warming. The phenological response of individual species was modified by community composition and functional diversity of the stand. Freeze-thaw cycles significantly increased aboveground productivity and vegetation cover of grassland early in the first growing season after manipulation with no significant reaction for heath. However, without further manipulation, productivity of heath communities dropped significantly in the freeze-thaw treated plots in the second year, whereas no longer any effect was found in the grassland communities. Heath systems appear to be more vulnerable to nutrient loss as they lack growth promotion in the first spring and suffer afterwards.

The results show the high ecological importance of extreme weather events on plant performance and ecosystem functions.

Experimental increases in diversity and evenness improve productivity and reduce weed invasion in intensive grasslands

Andreas Lüscher (1), John Finn (2), Teresa Sebastià (3), Laura Kirwan (2), Caroline Brophy (4), Olivier Huguenin-Elie (1), Aslaug Helgadóttir (5) & John Connolly (4)
(1) Agroscope Reckenholz-Tänikon Research Station ART, CH-8046 Zurich, Switzerland
(2) Teagasc, Johnstown Castle, Co. Wexford, Ireland
(3) Forest Technology Centre of Catalonia, University of Lleida, 25280 Solsona, Spain
(4) Environmental and Ecological Modelling Group, School of Mathematical Sciences, UCD, D4, Ireland
(5) Agricultural University of Iceland, Keldnaholt, 112 Reykjavík, Iceland

The pan-European COST 852 Agrodiversity Grassland Experiment used a novel modeling approach to quantify the relationship between diversity and ecosystem functions in an agronomic model system. Total aboveground biomass for the first three years after sowing and the weed component of that biomass were analysed for 12 sites that used the same mid-European species. At all sites, mixtures consisted of two legumes (*Trifolium pratense, T. repens)* and two grasses *(Lolium perenne, Dactylis glomerata)*. Using a simplex design, 15 experimental communities were sown with varying levels of evenness and the design was repeated at two levels of overall initial abundance (based on seed weights). Communities consisted of monocultures (100:0:0:0), mixtures dominated in turn by each species (70:10:10:10), mixtures dominated in turn by pairs of species (40:40:20:20), or communities with each species equally represented (25:25:25:25). Yield at each harvest was sampled by harvesting a subplot (≥3 m^2) to a height of 5 cm.

In each of the three years, the average yield of mixtures was greater than the yield of monocultures (Fig. 1). While the average weed biomass of the monocultures increased from 15% in year 1 to 40% in year 3, weeds consistently contributed only about 5% of the total yield of the mixtures. By year 3, the average yield of the original sown species in mixture was more than double that in monoculture. There were clear indications of transgressive overyielding in the first harvest year [1] and preliminary analysis of the 12 sites indicated that all mixtures yielded significantly ($p<0.01$) more than the highest yielding monoculture in subsequent years. Within harvest years 1-3, the average total annual yield of mixtures was estimated as being 6%, 20% and 16% greater than that of the highest yielding monoculture. A novel modeling approach investigated whether benefits were related to community evenness.

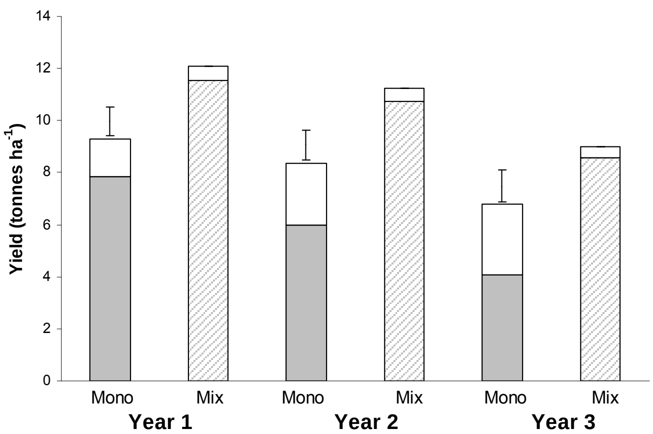

Fig. 1: Average annual yield of sown (shaded) and unsown (white) species in mixtures (mix) and monocultures (mono) for three years across the 12 sites. A bar shows least significant difference between mean total annual yield of monocultures and mixtures.

[1] Kirwan L., Lüscher A., Sebastià M.T., et al. (2007) Evenness drives consistent diversity effects in an intensive grassland system across 28 European sites. *Journal of Ecology* 95, 530-39.

Invasibility of grassland communities: The role of plant diversity, plant functional group identity and earthworms

Nico Eisenhauer (1), Alexandru Milcu (2), Alexander Sabais (1) and Stefan Scheu (1)
(1) Darmstadt University of Technology, Institute of Zoology, Schnittspahnstraße 3, 64287 Darmstadt, Germany
(2) NERC Centre for Population Biology, Division of Biology, Imperial College London, Ascot, UK

Invasions of natural communities by non-indigenous species are currently rated as one of the most important global-scale environmental problems. Biodiversity is one feature of communities that has long been hypothesized to reduce invasions and increase stability. In this context, ecosystem engineering doubtlessly has the potential to affect the distribution, establishment, and abundance of species, however, ecosystem engineers have widely been ignored in studies focussing on diversity-invasibility relationships. In order to investigate the effects of earthworms on plant invasion and the underlying mechanisms, we performed a greenhouse experiment (A) and determined natural plant invasion (B).

(A) In a greenhouse experiment we investigated the impact of *Lumbricus terrestris* L., plant functional group identity and seed size of plant invader species and plant functional group of the established plant community on the number and biomass of plant invaders. Therefore, we set up 120 microcosms comprising four plant community treatments, two earthworm treatments and three plant invader treatments containing three seed size classes. The results indicate that small scale disturbances and open gaps represented by the bare ground treatments are essential regeneration niches but also patches of increased probability for plant invasion in grassland communities. *Lumbricus terrestris* functions as a driving agent of plant recruitment and plant community composition by burying, ingesting and digesting plant seeds.

(B) We determined natural plant invasion into plots varying in plant species (1, 4, and 16 species) and plant functional group diversity (1, 2, 3, and 4 plant functional groups) for three vegetation periods two years after establishment of The Jena Experiment. Thereby, we weeded subplots with earthworm addition and earthworm reduction, respectively, to investigate effects of an important ecosystem engineer in temperate grasslands. Additionally, we performed a seed-dummy experiment to investigate earthworm soil surface activity in a plant diversity gradient. Soil surface activity was decreased considerably on earthworm reduction subplots indicating successful density manipulations. Further, earthworm soil surface activity was decreased with increasing plant species diversity and presence of grasses but increased in presence of small herbs. Invasibility decreased and stability increased with increasing plant species diversity. Thereby, coverage of the resident plant community (light availability) and fine root biomass (belowground nutrient competition) presumably govern community invasibility. However, the present study highlights the intimate relationship between earthworms as ecosystem engineers and plant species diversity, functional group identity and structural complexity for the invasibility and stability of grassland communities. Earthworms modulated the well-known diversity-invasibility relationship by increasing plant invader numbers and diversity and by decreasing the stability of grassland communities, respectively. This means that principal mechanisms of plant communities are modulated by faunal components.

Nitrogen partitioning by soil depth among grassland plants at different levels of species richness

Stefanie von Felten (1), Pascal A. Niklaus (1), Michael Scherer-Lorenzen (1), Andrew Hector (2) & Nina Buchmann (1)
(1) ETH Zurich, Institute of Plant Science, Universitaetstr. 2, 8092 Zurich, Switzerland
(2) University of Zurich, Institute of Environmental Sciences; Winterthurerstr. 190, 8057 Zurich, Switzerland

Resource partitioning due to niche separation among species has often been suggested as a mechanism to explain the positive relationship between plant species richness and productivity in temperate grasslands. Differences among species in their resource use may result in more complete resource exploitation of species-rich compared to species-poor plant communities. Nitrogen (N) is quantitatively the most important mineral nutrient for green plants, and is seen as the major limiting nutrient to primary production in temperate ecosystems. Recently, quite a number of ^{15}N-labelling studies investigated chemical partitioning of N. However, hardly any of them addressed partitioning of N by soil depth, although species differences in their vertical distribution of root biomass and activity are well known.

In a pot experiment with plant communities of one, two, and four species of forbs and grasses, we tested whether species richness affects species' N uptake from shallow vs. deep soil. We mixed an organic ^{15}N label directly to natural field soil, allowing it to undergo microbial mineralization. Tracer uptake by plants was determined at three destructive harvests in two consecutive years. We hypothesized (1) that niche overlap (Proportional Similarity) with respect to N uptake between species decreases with increasing species richness, (2) that smaller niche overlap is correlated with larger complementarity effects (sensu Loreau & Hector, 2001), and (3) that total ^{15}N/N uptake of communities increases with species richness, due to increased uptake from deep soil.

As expected, niche overlap between species decreased with species richness. However, this was mainly due to smaller overlap in mixtures (realized niches) compared to monocultures (fundamental niches), while no differences were found between two- and four-species mixtures. Unexpectedly, smaller niche overlap between species within a mixture was not related to larger complementarity effects. ^{15}N-tracer uptake of plant communities increased only marginally with species richness, again with the difference mainly between monocultures and mixtures. However, this was rather due to increased mixture biomass than increased N uptake from deep soil.

Although we cannot exclude that higher N uptake of mixtures resulted from species complementarity along other niche axes not tested here, or along multiple niche axes, our study provides no evidence for N partitioning by depth as a major cause of species complementarity. However, interspecific competition led to shifts in species N uptake patterns that may be termed „phenotypic character displacement".

Phenotypic plasticity varied greatly among grass species and functional traits along a plant diversity gradient

Marlén Gubsch (1), Christiane Roscher (2), Bernhard Schmid (3), Ernst-Detlef Schulze (2) & Nina Buchmann (1)
(1) Institute of Plant Sciences, ETH Zürich LFW C56, Universitätsstrasse 2, CH-8092 Zürich, Switzerland
(2) Max Planck Institute for Biogeochemistry, POBox 100164, D-07701 Jena, Germany
(3) University of Zürich, Institute of Environmental Sciences; Winterthurer Str. 190, 8057 Zürich, Switzerland

Phenotypic plasticity may serve as a strategy for plants to cope with altering environmental conditions and to optimize resource acquisition and use. Variation in the expression of species-specific functional traits has thus been studied empirically for a variety of conditions, including changing nutrient availability, light quality, consumer pressure or even in relation to the presence or identity of neighbors. However, very little is known about the plastic response of plant functional traits under changing competitive pressure along a plant diversity gradient.

Utilizing a long-term, large-scale biodiversity experiment (The Jena Experiment - Germany) where plant species richness levels range from one to 60 species, we focussed on 13 different species within the functional group of the grasses, investigating the plasticity of several morphological and physiological traits. Trait measurements were taken on a single-shoot basis and were recorded twice in 2006. Additionally, the same measurements were also taken in a "Plant Individual Garden", where all species were grown as individuals without competition.

We observed a large overall plasticity only in traits that reflect nitrogen capture (such as leaf $\delta^{15}N$, leaf nitrogen concentration) and light use (such as leaf area ratio, leaf mass fraction). Species- and environment-specific responses were observed for other traits: stem and internode length as well as specific leaf area. These responses allowed particular grass species to adjust to changing competitive conditions. Species greatly differed in the number of traits that were used for plastic adjustments to environmental conditions; and the magnitude of plastic responses for particular traits also varied among species. Small statured grasses showed the highest plasticity, whereas already dominant species hardly adjusted their traits. In comparison with monocultures, plasticity increased with increasing plant diversity for most of the species and traits.

We conclude that a) phenotypic plasticity of grass species is trait-specific and only a few traits exist that are generally highly plastic, and b) that only species strongly suppressed by others invest into plasticity, despite obvious costs, in order to maintain their performance. On the other hand, our results demonstrate that c) the magnitude of plasticity increases with competitive pressure, leading to wider niche use in highly-diverse communities.

Plant-soil feedback across a plant diversity gradient: The Home and Away Jülich experiment

Vicky M. Temperton (1), Charlotte Mevissen (1), Lindsay Turnbull (2), Alexandra Weigelt (3), Wolfgang W. Weisser (3) & Ingar Janzik (1)
(1) Institute of Chemistry and Dynamics of the Geosphere (Phytosphere ICG-3); Forschungszentrum Jülich, Jülich, Germany
(2) Institute of Environmental Science, University of Zürich, Zürich, Switzerland
(3) Institute of Ecology, Friedrich-Schiller-University, Jena, Germany

Many biodiversity-ecosystem functioning experiments are conducted in grasslands, where the effect of a plant diversity gradient on productivity and nutrient cycling is investigated over time, by comparing performance in mixtures with that in monocultures. Root herbivores and pathogens can affect the abundance and fitness of species in plant communities [1], especially in monocultures, where an accumulation of specialised pathogens may occur. It is possible that such plant-soil feedback could explain some of the differences in productivity between monocultures and mixtures found in biodiversity experiments.

A previous plant-soil feedback experiment in similar temperate grassland using monoculture soils only, where species were grown back on their own (home) or another species' soil (away), found large advantages for many species when growing in away soils, especially under conditions of inter-specific competition [2]. We do no yet know whether such effects would be diluted across a plant diversity gradient. To test this, we set up a greenhouse experiment using soils collected from across the plant diversity gradient (1,2,4,8 species) of the Jena Experiment [3] and species grown either on their own soil (home) or on another functional group's soil (away) across the diversity gradient. Soil (gamma irradiation versus control) and plant competition treatments (intraspecific/interspecific) were also included in the soil monoculture part of the experiment. In addition, several secondary and nitrogen-associated primary metabolites were analysed in a selection of species across the diversity gradient.

We hypothesised that there would be a large difference in plant performance in monocultures when growing away versus home, and that home/away differences would be much smaller as the diversity of plants previously growing in the soil increased. Initial results on total community biomass per pot suggest that the expected dilution effect across the diversity gradient only partially corresponds to diversity-productivity relationships found in the field, with significantly higher biomass in the 8-species assemblages only. Presence of legumes seems to be a key driver in affecting response to growing at home vs. away or gamma irradiation, indicating that legume presence (more than dilution of plant-soil feedback by species richness) is driving the plant-soil pathogen interaction in this grassland.

[1] Van der Putten, W. (2003) Ecology 84
[2] Petermann J. et al. (in press) Ecology
[3] Roscher C et al. (2004) Basic and Applied Ecology 5

Potential of grass-legume mixtures for high forage production and low N_2O losses

Olivier Huguenin-Elie (1), Daniel Nyfeler (1,2), Matthias Suter (1), Emmanuel Frossard (2), Cornelia Fischer (1), Albrecht Neftel (1) & Andreas Lüscher (1)
(1) Agroscope Reckenholz-Tänikon Research Station ART, CH-8046 Zurich, Switzerland
(2) Institute of Plant Sciences, ETH Zurich, CH-8044 Zurich, Switzerland

Pure swards of key grass species produce high forage yields when strongly fertilised with nitrogen (N). However, N fertiliser production and application is a source of negative environmental impacts. Production systems with reduced N fertiliser input but making use of positive biodiversity effects could be an alternative. While most studies on the effects of species diversity in grassland ecosystems focused on the influence of species richness (number of species) under relatively nutrient poor conditions, we examined the effect of species relative abundance (evenness) under fertile agronomic conditions.

Pure and mixed stands with widely varying sowing proportions (from 10 to 70% for each individual species) of two grass species (*Lolium perenne*, *Dactylis glomerata*), and two legume species (*Trifolium pratense*, *T. repens*) were established following a simplex design [1]. The swards were fertilised with either, 50, 150 or 450 kg N ha^{-1} yr^{-1}, hereafter referred to as N50, N150 and N450. Total yield, N yield, N from symbiotic N_2 fixation and N_2O emissions were measured to give insight into productivity and ecosystem functioning.

Overyielding was observed for all mixtures but was larger for the mixtures with equal sowing proportions of all species than for mixtures dominated by one species. The magnitude of overyielding of the centroid mixtures was 62%, 55% and 47% of the yield expected from the average yield of the four monocultures at N50, N150 and N450 respectively. The yield of the mixtures even exceeded that of the most productive monoculture (transgressive overyielding) over a wide range of relative species abundance. Thus, the diversity-productivity effect was agriculturally interesting at different levels of evenness. As a result of this very strong diversity-productivity effect the yield of the grass monocultures fertilised at N450 did not exceed the yield of the highest yielding mixtures fertilised at N50. Symbiotic N_2 fixation in the mixtures with equal sowing proportions contributed 54%, 36% and 14% to the quantities of harvested N at N50, N150 and N450 respectively. This fertilisation induced decrease in the amount of N_2 fixed was due to a down-regulation of the N_2 fixing activity of the individual legume plants and to a significant reduction of the legume proportion in the sward. Our results show that mixed swards emitted less N_2O than legume monocultures.

In conclusion, well balanced grass-legume mixtures fertilised with only 50 kg N ha^{-1} yr^{-1} produced similar forage yields to grass monocultures fertilised with 450 kg N ha^{-1} yr^{-1} and emitted less N_2O than legume monocultures. This demonstrates the large potential of well balanced grass-legume mixtures for producing high forage yield with low environmental burdens of production.

[1] Kirwan L., Lüscher A., Sebastià M.T., et al. (2007) Evenness drives consistent diversity effects in an intensive grassland system across 28 European sites. *Journal of Ecology* 95, 530-39.

Relationship between plant diversity and aboveground or soil N pools: the influence of time since establishment

Yvonne Oelmann (1), S. Rosenkranz (1), A. Richter (1), N. Buchmann (2), N. Eisenhauer (3), G. Gleixner (4), M. Habekost (4) A. Milcu (5), C. Roscher (4), S. Scheu (3), S. Steinbeiss (4), V. Temperton (6), A. Weigelt (7), & W. Wilcke (1)
(1) Johannes Gutenberg-University Mainz, Geographic Institute; Johann Joachim Becher-Weg 21, D-55128 Mainz, Germany
(2) Institute of Plant Sciences, ETH Zurich LFW C56, Universitätsstrasse 2, CH-8092 Zurich, Switzerland
(3) TU Darmstadt, Biology; Schnittspahnstr. 3, D-64287 Darmstadt, Germany
(4) Max Planck Institute for Biogeochemistry, POBox 100164, D-07701 Jena, Germany
(5) Center for Population Biology, Silwood Park, Imperial College London, Berkshire SL5 7PY, UK
(6) Institute of Chemistry and Dynamics of the Geosphere, ICGIII Phytosphere Institute, Jülich Research Centre, D-52425 Jülich, Germany
(7) Friedrich Schiller University Jena, Institute of Ecology; Dornburger Str. 159, D-07743 Jena, Germany

Several studies in grasslands have confirmed the hypothesis that increasing plant diversity contributes to more effective resource use resulting in decreasing concentrations of plant-available nutrients in soil. These results, however, were primarily based on short-term experimental plant communities (maximum age two years). After seeding, nutrient cycling in these plant communities will change depending on the shift from former (mostly arable land) to actual (meadows mown twice a year and regularly weeded) land-use practices. The period of establishment with respect to nutrient cycling raises the question whether plant diversity effects change over time in these experimental communities. Each autumn from 2003 to 2007, we studied the effect of plant diversity (1 to 60 grassland species in mixtures) on aboveground N storage and nitrate concentrations in soil in the 'Jena Experiment'.

Aboveground N storage differed among years, but did not show a temporal trend. N storage in aboveground biomass was consistently significantly related to plant diversity. The slope (plant diversity as $\log_2$; b: 0.62 to 1.00) of this relationship did not change over time. Therefore, diverse plant communities used N resources in soil more exhaustively throughout the first five years of the experiment.

Nitrate concentrations in soil differed among years but showed no temporal trend. Total N storage in soil (2002-2006) and microbial biomass (2003-2007) significantly increased through the course of the experiment. Plant diversity negatively affected nitrate concentrations in soil in autumn 2003, 2004, and 2005. The negative slope increased from 2003 to 2005 (plant diversity as $\log_2$; b: -0.26 to -0.13) but there was no relationship between plant diversity and soil nitrate concentrations in 2006 and 2007. Moreover, we found significantly increasing nitrification rates with increasing plant diversity in a laboratory incubation. Considering that more N was stored in soil over the course of th experiment, we infer that over time nitrification increasingly compensated for increased N uptake of diverse plant communities.

We conclude that in experimental setups plant diversity effects on soil and plant community nitrogen depend on the time since establishment and might be counterbalanced by processes occurring during land-use shifts. Our findings underline the importance of long-term perspectives in diversity experiments.

Tree seedling diversity and its impact on ecosystem productivity

Josephine Haase (1,2), Harald Auge (1), Andrew Hector (2) & Daniel Prati (3)
(1) Helmholtz Centre for Environmental Research – UFZ, Department of Community Ecology; Theodor-Lieser Str. 4, 06120 Halle, Germany
(2) University of Zurich, Institute of Environmental Sciences – IfU, Switzerland
(3) University of Bern, Institute of Plant Sciences, Switzerland

A hotly debated issue in current ecological research are the consequences of declining biodiversity for ecosystem functioning. However, we lack a resource-based mechanistic understanding of how biodiversity affects ecosystem processes. The mechanisms that control plant diversity are still being debated in ecology but plant competition is usually thought to be a key process that structures plant communities. In contrast to grassland ecosystems, these relationships have hardly been studied in forest ecosystems. However, there is a great need for studying the functional consequences of tree species diversity, particularly now as Central European forestry is conducting a broad-scale conversion of monocultures into mixed forest stands.

We established a pot-experiment to (1) investigate intra- and interspecific competitive interactions between seedlings of the tree species *Fagus sylvatica*, *Fraxinus excelsior*, *Pinus sylvestris*, *Tilia cordata*, *Quercus petraea*, *Picea abies* and (2) to improve our understanding of the relative importance of these interactions for the coexistence of tree species in the long term.

Preliminary results indicate a positive relationship between tree seedling diversity and productivity at low density only, with the main difference from monocultures to species mixtures [Fig. 1]. We will present more detailed analyses on the effects of intraspecific *vs* interspecific competition and on the effects of single species and certain species mixtures.

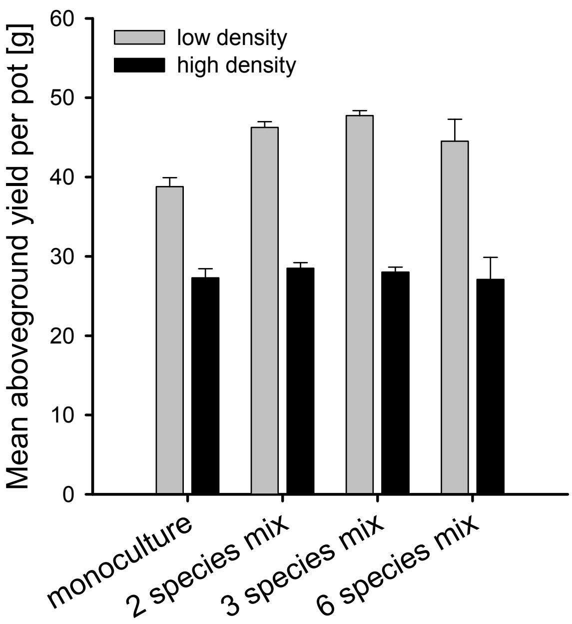

Figure 1: Effects of tree seedling diversity on the productivity in tree communities of different density. Low density = 6 tree individuals per pot; high density = 12 tree individuals per pot. Values are means ± standard error.

From pure to mixed: Is there a relationship between understorey vegetation biodiversity and nutrient cycling in former Norway spruce forests?

Steffi Heinrichs & Wolfgang Schmidt
University of Goettingen, Department Silviculture and Forest Ecology of the Temperate Zones; Büsgenweg 1, 37077 Goettingen, Germany

The conversion of pure, even-aged coniferous forests into ecologically adapted deciduous and/or mixed stands is a main goal of forest management in Central Europe. Selective cutting will be the main method for stand transformation, however in sites highly susceptible to frequent storm events small scale clear-cuttings (up to 1 ha) might be useful, what will affect the forest ecosystem severely for example in terms of nutrient leaching. The understorey vegetation then plays an important role as a nutrient sink.

In an exemplary large-scale and long-term BACI (before-after/control-impact)-experiment in the Solling hills (Lower Saxony, Germany) the immediate effects of these two felling methods on the diversity and productivity of the understorey vegetation in Norway spruce stands on two different sites were investigated. The vegetation was sampled before treatment and for four years after cutting on permanent plots.

As expected the clear-felled plots showed the largest changes in species composition and the highest species numbers compared to the initial state and unmanaged controls, whereas the impact caused by selective cutting was more moderate. The increasing plant species richness on the highly disturbed clear-cut plots can mainly be explained by forest species remaining on the plots under the shelter of pioneer shrubs and the invasion of species typical for open sites, beneath these fast growing in part nitrogen demanding species.

Here we address the question if the species richness of the understorey vegetation influences their contribution to the retention of nutrients in the ecosystem or if the occurrence of distinct species is the determining factor in reducing nutrient leaching. Results derive from harvesting of different species and from the use of the estimation model PhytoCalc [1], what allows a non-destructive estimation of aboveground herbaceous biomass as well as carbon and nutrient (N, K, P, Ca, Mg, S) storage by using cover values and shoot length.

[1] Bolte, A. (2006): Biomasse- und Elementvorräte der Bodenvegetation auf Flächen des forstlichen Umweltmonitorings in Rheinland-Pfalz (BZE, EU-Level II). Berichte des Forschungszentrums Waldökosysteme, Reihe B, Bd. 72.

Poster presentations

Inter-relationships of traits of woody species in a subtropical forest in Dujiangyan, Sichuan, China

Sabine Both, Wenzel Kröber, K. Bernhard von Hagen, Erik Welk, Helge Bruelheide
Martin Luther University Halle Wittenberg, Institute of Biology /Geobotany and Botanical Garden, Am Kirchtor 1, 06107 Halle, Germany

The objective of this study was to analyse inter-relationships and trade-offs between traits of tree and shrub species. The investigation was carried out in the context of the DFG Research Unit FOR 891 „The role of tree and shrub diversity for production, erosion control, element cycling, and species conservation in Chinese subtropical forest ecosystems“ (BEF-China). The natural vegetation of these forests is extremely species-rich with a high proportion of evergreen laurophyllous species in addition to deciduous ones. Species composition is mainly characterized by families with temperate distribution range (e.g. Fagaceae), but additionally with subtropical (e.g. Anacardiaceae, Lauraceae) and tropical ones (e.g. Symplocaceae, Theaceae, Rutaceae). We asked whether (1) general trait relationships that have been found across different communities and biomes do also exist within a single community and (2) to which degree these relationships might be attributed to phylogeny, i.e. to a common descent.

Morphological and anatomical traits were measured on 34 species from 18 plant families, comprising both shrub and tree species as well as evergreen and deciduous species. Traits referred to leaves (e.g. leaf nitrogen content, specific leaf area) as well as to wood structure (e.g. wood density). Trait inter-relationships were calculated with ordinary linear regression. Phylogenetic contrasts were calculated based on comparing conservative segments of the chloroplast *trn*L intron, using a UPGMA tree derived from Kimura distances . The WinCAIC software was used for phylogenetic correction of trait correlations by attributing the maximum possible trait variation to phylogeny and then inter-relate the residual variation of traits, using also ordinary linear regression.

We found numerous significant relationships among traits although the variance explained was quite low. Within leaf traits the best relationship was found for the carbon nitrogen ratio (CN), which was negatively related to both specific leaf area (SLA) and stomata density. No signficant inter-relationships were encountered for traits related to wood structure. In general, accounting for phylogenetic relations resulted in more or less the same relationships but in lower correlation coefficients. However, in some cases patterns emerged that were not apparent in uncorrected linear regression, e.g. a significant relationship of wood density to leaf nitrogen content.

The conclusion of our study is that the trait relationships observed across different habitats do also exist within a single community, although at first sight the species seemed to be functionally very similar physiognomically. We can also conclude that a significant portion of trait interrelationships is either attributable to phylogeny alone or to both phylogeny and ecology.

Positive species interactions enhance productivity at low and high levels of nitrogen addition and cutting severity.

T. Carnus (1,3), J.A. Finn (1), L. Kirwan (1,2) A. Cuddihy (1) and J. Connolly (3)
(1) Teagasc Environment Research Centre, Co. Wexford
(2) Eugene Lawler Graduate School of Computing, WIT, Co. Waterford
(3) Environmental and Ecological Modelling Group, School of Mathematical Science, UCD, Dublin 4

When environmental change occurs, ecological theory predicts that system-level processes are more stable in mixtures than monocultures [1]. In a grassland context we predict that, compared to monocultures mixtures maintain yield over a nitrogen gradient and show lower coefficient of variation (CV) (in yield) across different environmental conditions. Benefits of using mixtures are expected to be driven by the number and strength of interactions among different species, and more opportunity for compensatory dynamics. This study quantifies the contribution of species identity and evenness to biomass production in mixed grassland systems under different N addition and cutting regimes.

A split-plot field experiment was established in autumn 2006. At the main plot level, experimental grassland communities were established following a simplex design to systematically vary the evenness of the main plots [2]. Species used were: *Lolium perenne (G1), Phleum pratense (G2), Trifolium pratense (L1)* and *T. repens (L2)*. There were 4 split-plots with 4 different environmental conditions: two nitrogen treatments (45 and 200 kg/ha/yr N) crossed with cutting severity (5cm *vs.* 1cm). Aboveground biomass (DM - 3 harvests in year 1) was modelled with terms for identity effect (each of the four species), evenness, N addition and cutting. For each main plot, CV was calculated across the four sub-plots and regressed on evenness

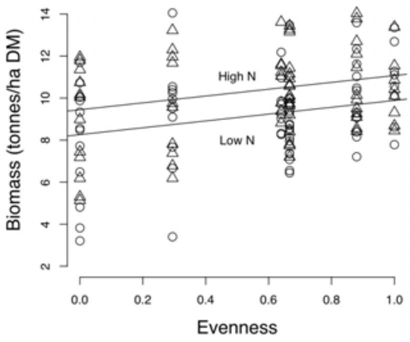

Fig. 1. Total yield at different levels of sown evenness. Lines represent high (triangles) and low (circles) levels of N addition

Mean yield at centroid (equal proportions of 4 species) at low N exceeded mean monoculture yield at high N (Fig. 1). The positive effect of mixture evenness was maintained at high N (Fig. 1) while grass-legume interactions decreased at high N; suggesting that increased biomass in mixtures is not solely due to symbiotic N-fixation. Evidence for decreased CV at higher evenness (Fig. 2) may indicate more reliability in mixture performance. Over successive years, benefits of mixtures in the experiment are expected to become more apparent as they encounter environmental fluctuation (effects of experimental conditions, and weather) and weed invasion

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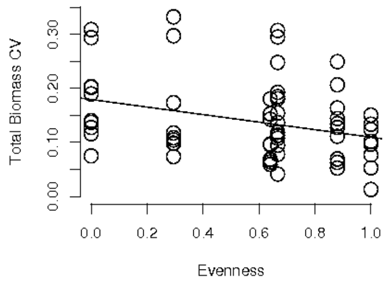

Fig. 2 Spatial CV for total biomass decreased with increasing evenness over the first year's harvest

[1] Yachi & Loreau (1999) Biodiversity and ecosystem productivity in a fluctuating environment: The insurance hypothesis. ***PNAS, 96, 1463-1468***
[2] Kirwan L. *et al.* (2007) Evenness drives consistent diversity effects in an intensive grassland system across 28 European sites. ***Journal of Ecology, 95, 530-539.***

The influence of tree root diversity on soil macrofauna in a deciduous forest

Simone Cesarz & Christian Platner
Georg-August-University of Goettingen, Ecology Group, Institute of Zoology and Anthropology, Berliner Str. 28, 37073 Goettingen, Germany, Contact: scesarz@gwdg.de*

From 2005 on, a diversity project was established in the Hainich National Park in Germany, Thuringia. The Hainich is the greatest cohesive forest area in Germany and a typical European deciduous mixed forest with beech representing the dominant tree species. In the diversity project three diversity levels were arranged ranging from low (dominated by beech) to medium (dominated by beech, ash and lime) to high (dominated by beech, ash, lime, hornbeam and maple) tree diversity resembling in climatic conditions and soil type. Within these levels a diversity gradient was found within saprophagous soil macrofauna. With increasing tree diversity most animal taxa increased in species number and density.

In this study, the clear separation of the effects of single tree species and diversity levels is conducted in a new approach in a balanced block design. Therefore, different small scale diversity clusters were established with emphasis on the rhizosphere. A cluster is composed of three trees building a triangle with no other tree roots influencing this area. Integrated tree species were the five dominant tree species beech, ash, lime, hornbeam and maple within the Hainich. One, two and three species clusters were set up giving all possible combinations of the dominant tree species. In these clusters soil and litter samples of 20cm ID were taken in May 2008 and macrofauna was extracted by heat.

We suggest that not only tree diversity influences macrofauna diversity and density. Beech, ash and lime as keystone species in the Hainich have a stronger impact on processes in the belowground influencing community structure and macrofauna diversity than other tree species.

Impact of quarrying on biodiversity

Tomas Chuman
Charles University in Prague, Faculty of Science, Department of Physical Geography and Geoecology, Albertov 6, Prague 2, 128 43 Prague, Czech Republic

In the past decades, quarries were regarded as undesirable elements in the landscape. Nowadays, they are considered as potentially valuable sites colonized by endangered species or species that are becoming less frequent in an agricultural landscape. This paper evaluates the impact of quarrying on biodiversity in the landscape near the town Skutec in the Czech Republic where quarrying of granodiorite led to a significant change of the landscape. The landscape surrounding abandoned quarries is mainly agricultural with patches of production forest. From the environmental gradients point of view, the study area is of average parameters compared to the rest of the Czech Republic e.g. average annual air temperature (6-7°C), average annual precipitation (650-700mm) and geological substrate (granodiorite) with rather low diversity of plant species. Pit quarrying technique was used in the slightly undulating landscape without marked altitudinal differences. This technique accelerated natural restoration because spontaneous succession started in the surroundings and on abandoned etages while the quarries were still in use. No additional restoration technique was used. The sites represent different stages of spontaneous succession from 10 to 50 years old. The species composition and species numbers were recorded within eight transects starting in undisturbed sites, going through disturbed sites (quarries and dump sites) and terminating in undisturbed sites. Sample plots were situated on representative places in each vegetation unit determined subjectively according to its physiognomy. On disturbed sites vegetation units were determined as follows (plot size 4x4m): full-grown woody vegetation; young woody vegetation; shrubby vegetation; dense herbaceous vegetation with scattered shrubs and trees; dense herbaceous vegetation; rare herbaceous vegetation of initial soils; wetland vegetation; scree vegetation; vegetation of ledges on quarry walls; continuously disturbed vegetation by anthropogenic activity (recreation). On undisturbed sites vegetation units were determined as follows (plot size 4x4m for non-woody vegetation and 50x50m for woody vegetation): production mixed forest; production monoculture spruce forest; shrubby vegetation of undisturbed sites; field; meadow; abandoned meadow.

There were 182 species recorded (herbaceous and woody plant species). Only 25 species that were recorded in undisturbed sites were not present in disturbed sites, on the other hand there were 60 species recorded in disturbed sites that were missing in the surroundings. Those species, missing in succession stages, represent meadow species, forest species of deeper soils and annual field weeds. Species present in disturbed sites and missing in the surroundings represent species of xeric sites, nutrient poor sandy soils, species of wetlands and species missing in intensively managed agricultural and forestry sites.

This study suggests that old abandoned spontaneously revegetated quarries and dump sites may play a significant role in landscape biodiversity. However the results primarily illustrate how much the surrounding landscape is impoverished considering plant diversity unlike how quarries contribute to biodiversity. Such sites harbor species vanishing from the rural landscape due to fertilization, land use changes etc.

Consequences of land-use change on biodiversity in coppiced beech forests in Central-Appennines (Italy) – preliminary results

Janos Garadnai (1), Giandiego Campetella (1), Roberto Canullo (1), Elia Angelini (1) & Marco Cervellini (2)
(1) University of Camerino, Department of Environmental Sciences sec. Botany and Ecology;Via Pontoni 5, 62032 Camerino, Italy
(2) University of Bologna
e-mail:janos.garadnai@unicam.it

Appennines forests have been managed by human for thousands of years. In Central Italy, coppicing is a traditional and still predominant method of woodland management, in which young tree stems are cut down to near ground level. Such management type played for a long time a prominent role within the socio-economic structure of marginal areas, by providing firewood, charcoal, and by offering grazing areas for livestock [1,2]. It is also characterized at 70% of the mountain beech (*Fagus sylvatica*) woodlands where is often applied in small stands (0,5-2 Ha) over a short cycle of 25-35 years. Previous results on the regeneration process in stands suggest that high landscape-scale heterogeneity and complexity due to high spatiotemporal variability of forest management maintain rich regional species pool [3].

At the present time, this tranditional land use system is changing and an increasing rate (presently 21%) of areas are abandoned. These changes call for important questions about forest management and diversity conservation in this landscape[4,5].

We hypothesize that beech forests differ in biodiversity depending on landscape heterogeneity level according to management activity. This summer we compared three pairs of beech forest patches (abandoned vs. still under active coppicing) each of around 80-100 ha, located in Central-Appennines. The vascular plant diversity was assessed by a probabilistic sampling (20x20m plots, placed in a regular grid) where phytocoenological relevees were made. Structural data were collected also, to demonstrate the different managment status. Our preliminary results on vascular plant diversity status of the abandoned and active beech forest landscapes will be detailed illustrated.

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[2] Amorini E, Fabbio G. 2001. La gestione del bosco ceduo nelle aree protette. Inform Bot Ital 33(1):164.-168.
[3] Bartha S, Merolli A, Campetella G, Canullo R 2008. Changes of vascular plant diversity along a chronosequence of beech coppice stands, central Apennines, Italy. Plant Biosystems (in press)
[4] Amorini E, Bruschini S, Cutini A, Di Lorenzo MG, Fabbio G. 1996. Treatment of Turkey oak (*Quercus cerris* L.) coppices. Structure, biomass and silvicultural options. Annali Ist Sper Selv Arezzo 27:121.-129.
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Seasonal changes in the soil microbial community in a grassland plant diversity gradient

M. Habekost (1), N. Eisenhauer (2), S. Scheu (2) and G. Gleixner (1)
(1) Max Planck Institute for Biogeochemistry, Germany
(2) Darmstadt University of Technology, Germany

Aboveground plant diversity is known to influence belowground diversity and ecosystem processes. Less is known on the effect of plant diversity on soil microbial communities. Therefore, we investigated the effects of vegetation cover, varying plant biodiversity and season on soil microbial parameters in a temperate grassland ecosystem.

In May and October 2006 mixed soil samples were taken from the field site of The Jena Experiment; a large biodiversity experiment in Germany which was established in 2002 on a former agricultural field. Sampled plots differed in plant species richness (0, 4, 8, 16), number of plant functional groups (0, 1, 2, 3, 4), and plant functional group composition. We measured basal respiration (BR) and microbial biomass ($C_{mic/CFE}$; chloroform fumigation extraction method), phospholipid fatty acids (PLFA), and substrate induced respiration (SIR).

We found distinct seasonal variations in microbial community structure; BR and amount of PLFAs were higher at the end of the vegetation period than in spring which was primarily due to increased biomass of fungi and gram negative bacteria. Furthermore, BR and amount of PLFAs were higher on vegetated plots than on bare grounds. Although the number of plant functional groups had no effect on microbial parameters, plant species richness affected the amount of PLFAs at the end of the vegetation period with higher biomass in 4- than in 8- and 16-species mixtures. Moreover, the proportion of gram negative bacteria was increased whereas the proportion of fungi was decreased in presence of legumes.

The present study showed distinct seasonal changes in the soil microbial community composition which is probably driven by the availability and quality of organic resources. Furthermore, our results highlight the time-lag of belowground responses to aboveground vegetation manipulations with only few significant changes four years after the establishment of the experiment.

Functional trait shifts as an effect of soil disturbance

Tim Krone Schnoor, Hans Henrik Bruun & Pål Axel Olsson
Lund University, Departement of Plant Ecology and Systematics, The Ecology Building, Sölvegatan 37
223 62 Lund, Sweden

Disturbance can have profound effects on vegetational structure, composition and diversity. The role it plays in successional patterns of plant communities makes it important for restoration. We focused on the effects of soil disturbance on the functional trait composition. We performed a disturbance experiment in a partly degraded sand steppe habitat in Eastern Scania, Sweden, where we plowed and harrowed large strips in a randomized block experiment. We collected species abundances, environmental data and functional trait data, such as SLA, canopy height, tensile strength. Here we present the results one year after the disturbance.

The treatments lead to two distinct vegetational communities, one disturbed and one non-disturbed, with typical ruderal species more abundant in the disturbed treatments. However, there was also a difference, although less distinct, between the plowed and harrowed treatment as shown by the PCA ordination diagram (Fig1).

We saw a separation between the traits governed by disturbance and those favoured by the more static control vegetation. Disturbance increased SLA and seed weight, while no disturbance favoured clonality, mychorrhizal colonisation and high structural investment in the form of high tensile strength (Fig. 1).

These results show a shift in the dominating traits as an effect of disturbance. The shifts are large between disturbed and non-disturbed, but not as clear between different levels of disturbance. However, by following the development of these functional averages under several years, and measuring the same variables in a "desired" vegetation type (sand steppe), we may be able to determine which treatment gives a trait niche most comparable to the one existing in sand steppe.

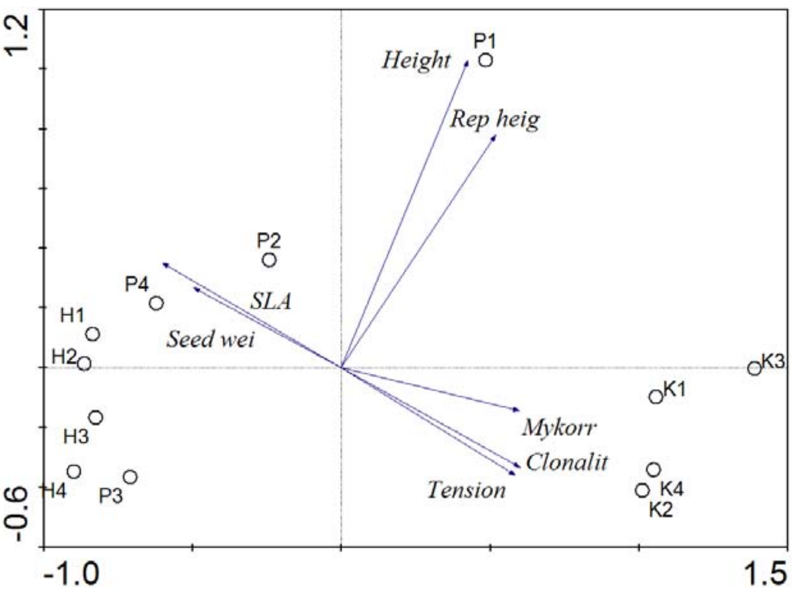

Figure 1. PCA with weigthed average values for each trait in each plot. P denote plowed plots, H harrowed and K Control plots. The ordination is based on a traits x plots matrice.

Trade-off between species richness and genetic diversity in experimental grassland

Elisabeth Marquard (1,3), Markus Fischer (2), Bernhard Schmid (3), Walter Durka (4)
(1) Max Planck Institute for Biogeochemistry, Jena, Germany
(2) Institute of Plant Sciences, University of Bern, Bern, Switzerland
(3) Institute of Environmental Sciences, University of Zürich, Zürich, Switzerland
(4) Helmholtz Centre for Environmental Research - UFZ, Halle, Germany

The number and abundance of plant species in a community may have a causal effect on the genetic composition and diversity within the plant populations either by having an impact on the selection pressure that is experienced by plant individuals within the community or by determining the strength of non-selective processes such as genetic drift. The influence of species diversity on genetic diversity could be positive (e.g. if more species create more diverse micro-habitats and therefore lead to diversifying selection) as well as negative (e.g. if inter- instead of intra-specific competition puts more stress on the individuals and therefore lead to directional selection with a narrowing of phenotypic variation). So far, few experiments have explored the causal relationship between plant species diversity within communities and genetic diversity within populations.

We analyzed the effects of plant species diversity on the genetic diversity within populations using a large-scale biodiversity experiment in Thuringia, Germany (The Jena Experiment). The Jena Experiment was created for investigating the effects of plant diversity on ecosystem processes. On 78 large 20 x 20 m plots, experimental plant communities were established that varied in species richness from 1 to 16. Within each diversity level, species were assembled randomly from a total pool of 60 local grassland species. All 60 species were additionally established in two replicate monocultures of 3.5 x 3.5 m. Out of the 60 species, we chose 16 target species for analyzing the relationship between species richness and genetic composition and diversity (5 grasses, 7 non-legume forbs and 4 legumes). In summer 2006, we collected the seeds of five individuals per target species in experimental communities of varying species richness (4–16 communities representing 2–5 different species richness levels depending on target species). The seeds were germinated and two randomly chosen seedlings were selected for genetic analysis. In addition, we germinated seeds of the originally sown seed material. Per target species, we included 5–15 of the emerging seedlings from this material in the analysis. Using AFLP-markers, we quantified the within-population diversity as well as the genetic distance between the different populations and between the two seedlings per maternal seed family. In each plot, the abundance of each target species was assessed by estimating its vegetation cover and by counting the number of shoots or rosettes on an area of 2 x 0.1 m^2.

For the seven target species analyzed so far, we could identify more than 100 polymorphic AFLP loci. The expected heterozygosity under Hardy-Weinberg genotypic proportions ranged between 0.2 and 0.4 in all populations. In *Onobrychis viciifolia*, the within-population genetic variability was higher in the originally sown seed material than in the populations sampled four years after sowing. This may indicate that the genetic diversity within the populations has changed during the course of our experiment.

Positive biodiversity and legume effects – How relevant are they along a gradient of nutrient availability?

Lea L.A. Märtin, Vicky M. Temperton
Research Center Jülich GmbH, Institute of Chemistry and Dynamics of the Geosphere (ICG), Phytosphere (ICG-3), 52425 Jülich, Germany

In recent years biodiversity-ecosystem experiments have found a firm link between plant diversity and ecosystem processes such as productivity and nutrient cycling, especially in mesic grassland systems [1-3]. The importance of facilitative processes such as positive effects of legumes on non-legume neighbours, in such biodiversity effects is still a critical issue. How much a legume contributes to the community's performance depends on the identity of the legume [4], the traits and diversity of the neighbours [5], as well as the abiotic conditions [6]. According to the stress-gradient-hypothesis [7] an increase in abiotic stress will strengthen facilitative plant-plant interactions.

One of the key questions arising from biodiversity experiments is their relevance to more natural or more extreme settings such as on degraded land in need of restoration. As such we hypothesized that facilitative effects between a legume species and an increasing gradient of neighbour diversity would increase along a nutrient availability gradient (from high to low). To do this we set up two greenhouse facilitation-competition experiments using a two-factorial design with different diversity levels and a gradient in nutrient availability in the substrate (no, low, medium and high N). The functional diversity was represented by legumes, grasses, tall and small herbs to test for both species and functional richness effects as well as for legume effects on productivity and plant N dynamics (using the natural abundance 15N method [8]). Initial results show that species richness had a positive effect on total plant biomass per pot (community biomass) especially under low N but also under medium N substrate conditions. Interestingly, there were no clear species or functional group richness effects under 'no N' conditions, and only small effects under high N. Similarly, under severe environmental stress (no N conditions) there was no positive legume effect on N content of neighbours, whereas facilitative effects were found under low N conditions.

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Uptake of intact amino acids from soil by plants - a matter of above- and below ground biodiversity?

Leopold Sauheitl (1), Michaela Dippold (1), Bruno Glaser (1) &, Alexandra Weigelt (2)
(1) University of Bayreuth, Institute for Soil Physics, Universitätsstr. 30, 95448 Bayreuth, Germany
(2) University of Jena, Institute of Ecology, Dornburgerstr. 159, 07743 Jena, Germany

Studies have shown the potential of plants to take up intact amino acids not only when grown in sterile hydro solutions but also in soil [1]. This was described the first time for a field study in subarctic soils, revealing low mineralization rates [2]. Further studies suggested that low mineral N concentrations in soil generally alter the significance of amino acid uptake for the N supply of plants [3]. N limitation, however, may not only be caused by low mineral N concentrations, but also by plant - plant and plant - micro organism competition. Though it is still not fully understood if and/or where biotic factors like biodiversity and plant - microbe competition, or abiotic soil variables are the main regulating forces for intact amino acid uptake.

To answer this question we investigated intact amino acid uptake in a plant diversity experiment in Jena, Germany. The target community of the experimental design was a semi-natural species-rich mesophilic grassland, including plots with varying numbers of grassland species and/or varying numbers of functional plant groups, which enabled us to differentiate between complementarity and the influence of functional groups. Double labelled (^{15}N, ^{13}C) amino acids were applied to the soil to determine uptake by plants via measurement of heavy isotope enrichment in the plants. Any overestimation of intact amino acid uptake caused by uptake of tracer fragments was precluded by substance specific GC-C-IRMS measurements.

Preliminary experiments showed that amino acid uptake can be measured in monocultures of *Festuca pratensis*, *Plantago lanceolata* and *Geranium pratensis* on the field site with this method. We thereafter investigated amino acid uptake in a biodiversity gradient reaching from 1 – 16 species and one to three functional groups, namely grasses, tall herbs and small herbs to elucidate the effect of aboveground biodiversity on intact amino acid uptake by plants. In addition the effect of aboveground biodiversity on the structure of the microbial community in the soil will be elucidated via PLFA measurements. These data will be supplemented by measurements of ^{13}C uptake of individual microbial groups and ^{13}C plus ^{15}N uptake of the whole microbial community to detail the plant to microbe competition for amino acids in the context of plant biodiversity.

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Historic development of the flora of Leipzig

Alexander Scholz (1,2), Sonja Knapp (1), Ingolf Kühn (1), Martin Freiberg (2) and Stefan Klotz (1)
(1) Helmholtz Centre for Environmental Research – UFZ, Community Ecology, Theodor-Lieser Str. 4, 06120 Halle, Germany
(2) University of Leipzig, Institute of Biology I, Special Botany, Johannisallee 21-23, 04103 Leipzig, Germany

Since the 18^{th} century many natural scientists have explored and recorded the flora of the city of Leipzig. Therefore, it is possible to track the changes in plant biodiversity for nearly 300 years. We analyzed data from [1] and [2]. The basic aim of our study is to distinguish functional plant groups that have been naturalized, gone extinct or remained during this time period. We especially ask

- Does the biodiversity of the flora of Leipzig increase?
- What plant traits increase the danger to be extirpated?
- What plant traits increase the chance to get naturalized or to remain?
- Are native species more likely to be extirpated than non-natives?

Due to the lack of continuous information for the complete time period, we divided the period into several time classes of different length. We compared several ecological and morphological functional groups taken from the trait databases BiolFlor [3] and LEDA [4]. These were the following morphological and ecological traits: dispersal-type, Ellenberg-indicator-values for moisture, nitrogen and temperature, floristic-status, leaf-anatomy, leaf-persistance, life-form, life-span, specific leaf area. We used time series analyses to investigate changes in plant trait frequency from 1726 to 2006. The statistical analyses were performed with the open source software R.

We will present our latest results. Our study will give insights into the various effects of urbanization on biodiversity and might point to future changes with ongoing urbanization. Hoping that it will help to predict and conserve the endangered species in the city of Leipzig.

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Interspecific differences in nitrogen uptake kinetic and utilization of six forest tree species

Horst Schulz (1) and Sigrid Härtling (1) and Florian Stange (2)
(1) Department of Soil Ecology, Helmholtz Centre for Environmental Research – UFZ, Theodor-Lieser-Str. 4, 06120 Halle, Germany
(2) Department of Soil Physics, Helmholtz Centre for Environmental Research – UFZ, Theodor-Lieser-Str. 4, 06120 Halle, Germany

The objective of this study was to determine the Michaelis-Menten kinetic parameters of NH_4^+ and NO_3^- for pine (*Pinus sylvestris)*, spruce (*Picea abies)*, oak (*Quercus petraea)*, beech (*Fagus sylvatica)*, lime (*Tilia cordata), and ash (Fraxinus excelsior)*. Uptake kinetic was measured in potted soils using $^{15}NH_4NO_3$ and $NH_4{}^{15}NO_3$ as tracers and expressed as maximum uptake (I_{max}) and ion affinity (K_m). Functional differences in nitrogen utilization between the tree species were determined by analysing of selected amino acids and expressed as glutamine/glutamic acid ratio. Two years-old tree plants were grown in mineral soil, collected from a humic cambisol; 18.12, 36.30, 54.45 and 72.60 mg ^{15}N tracer were injected into the soil, corresponding to 0.61, 1.21, 1.81 and 2.42 mmol $^{15}NH_4N$ or $^{15}NO_3N$ per 1 L soil water. The amounts of ^{15}N in roots and amino acids in needles/leaves were measured 72 h after tracer addition.

The ranking of I_{max} values (µg ^{15}N g^{-1} dry matter d^{-1}) for NH_4^+ uptake was ash (233.1), lime (133.4), pine (107.2), spruce (96.1), beech (61.2) and oak (43.4) and for NO_3^- uptake was ash (233.5), lime (213.5), pine (141.2), spruce (104.5), beech (83.1), and oak (47.8). The ranking of K_m values (mM) for NH_4^+ uptake was ash (0.84), lime (1.02), pine (1.14), spruce (1.33), beech (1.80), and oak (2.81) and for NO_3^- uptake was ash (0.60), pine (1.13), spruce (1.19), lime (1.34), beech (1.44), and oak (1.82). The ranking of Gln/Glu ratio was ash (0.66), spruce (0.52), pine (0.38), beech (0.33), oak (0.26), and lime (0.24).

Results of this study show that fast-growing species have a greater N-uptake capacity and N assimilation rate than slow-growing species. The differences in their functional traits may have a significant implication for competitive interactions and diversity responses.

Restoration of loess and alkali grasslands on former alfalfa fields

Béla Tóthmérész (1), Balázs Deák (2), Péter Török (1), Enikő Vida (1) & Szabolcs Lengyel (1)
(1) Department of Ecology, University of Debrecen; 4032 Debrecen, Egyetem tér 1, Hungary
(2) Hortobágy National Park Directorate; 4024 Debrecen, Sumen u. 2, Hungary
(1) e-mail: tothmerb@delfin.unideb.hu

Restoration of grasslands is a potential way to increase biodiversity on former fields. We are reporting the results of a grassland restoration experiment conducted as part of a landscape-scale rehabilitation programme in Hortobágy National Park (Egyek-Pusztakócs LIFE-Nature project). Here we address the following questions: (i) How do the low-diversity seed mixtures sown affect the biomass of early colonists? (ii) How do the species sown influence species richness and diversity of the early plant assemblages?

In 2005 we started the restoration of grasslands on 110 ha of former alfalfa fields. In October, after deep ploughing, we sowed loess seed mixture (*Festuca rupicola*, *Bromus inermis*, *Poa angustifolia*) on the loess plateaus, and alkali seed mixture (*Festuca pseudovina*, *Poa angustifolia*) in lower-lying areas. Percentage cover of vascular species was recorded in stationary plots and above-ground phytomass was sampled close to the plots in June 2006 and 2007.

In the first year, assemblages dominated by short-lived weeds (e.g. *Matricaria indodora*, *Polygonum aviculare*, *Chenopodium album, Fumaria officinalis*) were typical. By the second year, closed, grass-dominated vegetation formed, indicating a quick transition between weedy assemblages and perennial vegetation . The sown species affected the performance of short lived species negatively. The species numbers and the weight of herbaceous phytomass decreased significantly by year 2 ($p<0.001$) [Fig 1].

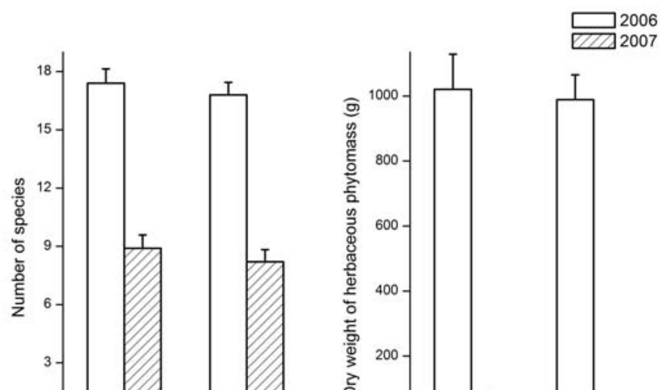

Figure 1: Species number and dry phytomass (mean+SE) of herbs on restored fields one and two years after the start of restoration.

Our results show that grassland restoration using seed mixture consisting of a few basic species is a fast and effective technique to restore grassland vegetation. To further increase species richness and naturalness of the restored fields, sowing of seed mixtures of herbaceous species, hay transport from non degraded sites, and/or moderated grazing are necessary.

Identification and sustainable use of ecosystem services

4.4. Biodiversity effects on litter decomposition: How, where and who?

Stephan Hättenschwiler, Tanya Handa

Oral presentations

Does litter decomposition differ between native and exotic plant species? A phylogenetically controlled experiment

Harald Auge (1), Urs Schaffner (2) & Maxi Huth (1)
(1) Helmholtz Centre for Environmental Research – UFZ, Department of Community Ecology, Theodor-Lieser Str. 4, 06120 Halle, Germany
(2) CABI Europe, Delémont, Switzerland.

Decomposition of plant litter represents a major link between the aboveground and the belowground subsystem, and is an important component of biogeochemical cycles. Litter decomposition is influenced by several plant functional traits, e.g. chemical composition and specific leaf area (SLA). Invasive plant species are often characterized by novel traits that may potentially affect litter decomposition. For instance, they frequently possess novel defense chemicals native invertebrates or microbes are not adapted to, which may slow litter decomposition. On the other hand, SLA of plant invaders is often higher relative to native plants, which may in turn accelerate decomposition. However, experimental evidence on litter decomposition of invasive plants is restricted to few case studies and does not allow generalizations. Therefore, we compared leaf litter decomposition of 13 deciduous tree and shrub species native to central Europe, and 13 exotic woody species. The experiment included a phylogenetically controlled subset of 7 pairs of native and exotic congeners, as well as 6 exotics without phylogenetically related native species, and 6 randomly selected native species. This allowed us to test the hypotheses (1) that decomposition of exotic leaf litter is, on average, lower than that of native leaf litter, (2) that this difference cannot be found between phylogenetically related species, (3) that decomposition rate depends on litter C/N ratio, total phenolics, and SLA, and (4) that the differences in decomposition between native and exotic litter persist even if corrected for these functional traits. The experiment was conducted using litter bags of two different mesh sizes (20 µm, 5 mm) to separate the effect of invertebrates from the effects of microbes on decomposition, and including three different populations of each species to explore intraspecific variation. First-order exponential decomposition rate varied between 0.0006 d^{-1} and 0.0073 d^{-1} for small mesh size, and between 0.0011 d^{-1} and 0.0287 d^{-1} for the large mesh size. In both types of litter bags, the invasive *Quercus rubra* had the lowest decomposition rate, and the native *Sambucus nigra* had the largest one. In contrast to our hypothesis, however, we found no consistent and significant difference in decomposition rate between exotic and native leaf litter. This was neither the case when all species were included in the comparison, nor when the phylogenetically controlled subset was considered alone. Moreover, we found no different response of exotic and native litter to the different mesh size, i.e. the presence or absence of invertebrates. However, there was substantial variation among the three populations of each plant species in terms of decomposition rate. Accordingly, neither C/N ratio, content of phenolics, nor SLA differed consistently between exotic and native species. However, multiple regression analysis revealed that decomposition rate was strongly dependent on the interactions between these leaf functional traits, but there was no difference between exotic and native species in these relationships. Additional feeding experiments with wood lice (*Porcellio scaber*) revealed a close correlation between

Abstract too long/cut

A global analysis of wood decomposition disentangling the roles of tree species, accessibility and environment

Christian Wirth (1), Angela Nüske (1), Hans Cornelissen (2), James Weedon (2), Will Cornwell (2), Amy Zanne (3)
(1) Max-Planck-Institut for Biogeochemistry, Hans-Knöll-Str. 10, 07745 Jena, Germany,
(2) Institute of Ecology, Vrije Universiteit Amsterdam, De Boelelaan 1085, 1081 HV Amsterdam, The Netherlands
(2) National Evolutionary Synthesis Center, 2024 W. Maine St, Durham, NC 22705, USA

In forests across the world deadwood forms a significant carbon pool, provides habitat for wood-dwelling species, germination substrate for tree seedlings and fuel for forest fires. The rate of decomposition is one important factor controlling the quantity and quality of deadwood and is therefore important in the context of carbon cycle modelling, conservation biology and forest ecology in general. Decomposition is a complex ecosystem process that depends on the activity of decomposers (including fragmenting insects), the accessibility of the substrate and substrate quality. Decomposer activity is largely controlled by temperature and moisture, substrate accessibility by the size and the positioning of deadwood, and the substrate quality by species-specific chemical and anatomical wood features. In this study, we integrate these factors to specifically identify the role of species identity and phylogeny on the speed of wood decomposition.

Our analysis is based on a global database of wood decomposition rates which was assembled as part of the Functional Ecology of Trees (FET) database project of the MPI for Biogeochemistry in Jena. The dataset contains over 700 individual records of decomposition rate estimated as the constant k of a negative exponential model for over 100 tree species from the boreal forest to the tropics. We apply Bayesian hierarchical modelling to merge observational data and generic trait information, to estimate genera and family effects and to impute missing values.

Across all species decomposition rates increase with log size, with the degree of soil contact and with temperature. We find that – keeping all other factors constant – angiosperm wood decomposes three times faster than gymnosperm wood ($k = 0.031 \pm 0.019$ yr^{-1} versus 0.11 ± 0.023 yr^{-1}. Within the angiosperms ring-porous wood decompose faster than wood from diffuse-porous species ($k = 0.135 \pm 0.021$ yr^{-1} versus 0.98 ± 0.018 yr^{-1}). Including wood density and durability scores improves the model slightly, but the respective parameters are not significantly different from zero. To assess the ecosystem-level impact of these differences we combined our decomposition rate estimates with published data on aboveground wood NPP to calculate equilibrium stocks of deadwood. These are predicted to be three times higher in conifer forests than in deciduous broad-leaved forests. This is confirmed by independent measurements in old forests near equilibrium.

Simulated drought and litter diversity effects on litter decomposition in a Mediterranean stream

Andreas Bruder (1), Eric Chauvet (2), and Mark O. Gessner (1)
(1) Department of Aquatic Ecology, Eawag: Swiss Federal Institute of Aquatic Science and Technology, and Institute of Integrative Biology, ETH Zurich, Überlandstrasse 133, 8600 Dübendorf, Switzerland
(2) EcoLab - Laboratoire d'écologie fonctionnelle, UMR 5245 CNRS, University of Toulouse, CNRS, National Polytechnic Institute of Toulouse, 29 rue Jeanne Marvig, 31055 Toulouse Cedex, France

Understanding the importance of species richness and species composition for ecosystem processes is critical to assess impacts of biodiversity losses on ecosystems. As most work on litter decomposition in this context has been phenomenological, the mechanisms behind any effects of litter mixing on decomposition remain poorly understood. We conducted a field experiment in a Mediterranean forest stream to assess whether drought effects on decomposition may be modulated by litter diversity, the hypothesis being that litter species traits influence microenvironmental conditions in litter during drought. Specifically, we expected litter species with high water holding capacity to retain humidity during litter exposure to air and thus improve habitat conditions for aquatic decomposers. For some litter species, such effects could result in greater decomposer activity after the drought compared to litter packs composed of single species. Faster decomposition would then be expected for some litter species in mixtures. We used coarse-mesh litter bags to expose standardized monospecific litter and litter mixtures of two indigenous species (alder and holm oak) that differ considerably in water holding capacity. To simulate a drought event, we transferred the litter bags to the stream bank for a period of seven days between two three-week exposure periods in the stream. There were no indications that mixture effects were associated with the experimentally imposed drought. Results indicate, however, that alder decomposed slower in mixtures with oak than in single-species litter bags. This negative mixture effect on alder leaves might be due to flow protection by the tough oak leaves or the influence of inhibitory compounds (e.g. tannins) leaching from oak litter on the decomposers associated with alder leaves. Further analyses will be necessary to link our observed mixture effects on decomposition with information on decomposer community structure, biomass and activity, to gain a mechanistic understanding of the interactions in decomposing litter mixtures and the effects of these interactions on decomposition rate.

Leaf traits, litter traits and decomposition rate of species from a secondary Mediterannean succession

Elena Kazakou (1), Eric Garnier (2), Cyrille Violle (2), Cristina Pintor (3), Olivier Gimenez (2) & Catherine Roumet (2)
(1) Département Ecologie et Santé des Plantes, Montpellier SupAgro 2 place Vila 34060 Montpellier France;
(2) Centre d'Ecologie Evolutive et Fonctionnelle, CNRS, 1919 route de Mende, 34293 Montpellier France
(3) Departamento de Ecología, Facultad de Biología, Universidad de Salamanca, 37071 Salamanca, Spain

The importance of litter quality in explaining interspecific variations in litter decomposition rates has been widely recognised. However, the idea that some traits of living leaves might have important "afterlife" effects on litter decay rates has only recently emerged. In this study, we addressed the following questions: (1) Which of leaf structural or chemical properties is the best predictor of litter decomposition, (2) how do leaf chemical, structural traits and litter decomposability co-vary among species differing in successional status, and (3) to which extent does N limitation affect species leaf traits and litter decomposability?

Leaf chemical and structural traits were assessed for 18 species differing in successional status, then in resource use, grown in a common garden experiment under limiting and non-limiting nitrogen supply. Litter decomposability was obtained under standard conditions.

Our results demonstrated that litter decomposability was successfully predicted by some traits of green leaves, especially those describing leaf robustness (leaf dry matter content, leaf tensile strength and leaf resistance to fracture). The leaf economic spectrum describing nutrient use in plants was found across species differing in successional stage. Species from early succession with high resource acquisition rates are replaced during succession by species which tend to conserve resources efficiently, the latter tending to produce leaves with low decomposition rates. Finally, in order to scale the species up to the ecosystem functioning, we propose to use leaf dry matter content as a functional marker of litter decomposability.

Litter quality is more important than richness for decomposition of litter mixtures in a woodland stream

Ferreira V. (1), Castela J. (2) & Graça M.A.S. (1,2)*
(1) IMAR – Instituto do Mar, Universidade de Coimbra, 3004-517 Coimbra, Portugal
(2) Depto. Zoologia, Universidade de Coimbra, 3004-517 Coimbra, Portugal
* veronica@ci.uc.pt

Species loss is currently occurring at an unprecedented rate worldwide, which makes it urgent to evaluate the relationship between diversity and ecosystem functioning. In particular, litter diversity has the potential to affect heterotrophic processes by altering first-order consumers' diversity and abundance. Small woodland streams are mainly heterotrophic as a result of being heavily shaded by the riparian vegetation that also contributes with organic matter which constitutes the basis of these aquatic food webs. The diversity of this organic matter depends on the diversity of the riparian vegetation, which has been decreasing due to anthropogenic activities. To evaluate the effects of decreased litter species richness on litter decomposition and associated invertebrates in a woodland stream, we incubated leaves of alder (A), oak (O) and chestnut (C), individually and in 2- and 3-species mixtures (7 treatments, 3 diversity levels: A, O, C, AO, AC, OC and AOC), in coarse mesh bags (10 mm mesh), during winter 2007. Litter bags were sampled after 7, 14, 28, 56 and 70 days in water, and mass loss was determined for each leaf species individually, even from mixtures. Invertebrates were collected from each litter bag, identified and counted. Mass loss of alder leaves was affected by litter species richness, with leaves in 3-sp mixtures decomposing faster than in 1- and 2-sp mixtures (ANCOVA, $p<0.026$), which translated into a significant and positive relationship between alder decomposition rates and litter diversity (linear regression, $p=0.022$, $R^2=0.96$). Decomposition rates of the 7 litter treatments were not affected by litter richness (linear regression, $p=0.865$), but were positively related with initial %N (linear regression, $p=0.013$, $R^2=0.74$), and negatively with initial %phenols (linear regression, $p=0.006$, $R^2=0.80$). At some dates, invertebrate abundance and richness were negatively affected by the presence of oak litter but not by litter diversity. Litter identity/quality played a grater role in the decomposition and invertebrate colonization of litter mixtures, although litter species richness also affected mass loss of individual species. Given that litter decomposition is highly affected by species identity, the only way to ensure ecosystem functioning in small, heterotrophic streams is to guarantee high tree diversity in the riparian corridor.

Decomposition of eucalyptus and alder mixtures: responses to variation in evenness

Ana Lúcia Gonçalves, Mafalda Gama, Cristina Canhoto
University of Coimbra, IMAR - Instituto do Mar, Departamento de Zoologia, Largo Marquês de Pombal, 3004-517 Coimbra, Portugal

The relationship between diversity and function has only recently been investigated in stream ecosystems. Here we evaluated the effect of litter evenness on litter decomposition in single and 2-species litter bags with *Alnus glutinosa* (A) and *Eucalyptus globulus* (E). The five evenness treatments (100%A, 25%E+75%A, 50%A+50%E, 75%E+25%A and 100%E) simulated the relative proportions of both leaf species throughout the year in a eucalypt stream lined by alder trees. Decomposition rates of eucalypt were retarded in the presence of alder, while those of alder were stimulated in the presence of eucalypt. Differences in mass loss between treatments were unrelated to the initial quality of the mixtures. Globally, the effects of litter evenness on microbial parameters (O_2 consumption, fungal biomass and sporulation) and invertebrate numbers ranged from undetected to weak, probably due to the high nutrient concentrations in the stream water which might have mitigated possible positive effects of alder presence on biotic activity associated with the nutrient poor eucalypt leaves. Although the effects of litter evenness on biotic parameters were idiosyncratic, the importance of species evenness on litter mass loss was suggested by the higher decomposition rates of the 50%A+50%E mixture, which is likely related with a trade-off between alder high nutrient quality (when compared with the 25%A+75%E mixture) and the stability promoted by eucalypt (when compared with the 75%A+25%E mixture). In parallel feeding preference tests, consumption of alder leaves by two species of shredders, *Sericostoma vitattum* and *Echinogmmarus lusitanus*, doubled when in the presence of eucalypt leaves than when alone. These studies suggest that alterations in litter evenness, resulting from changes in riparian composition and diversity, might affect litter decomposition, and consequently ecosystem function.

On the role of shredders in leaf litter processing from some lotic systems (Romania)

Preda E, Nistorescu M, Popescu C. & Ciubuc C.
University of Bucharest, Dept. of Systems Ecology and Sustainability; Splaiul Independentei 91-95, 050095 Bucharest, Romania

The decomposition of allochtonous organic matter is an essential process in the functioning of running waters. It is a complex process realized through chemical and physical transformations together with biological activity of different assemblages: fungi, bacteria, detritivorous invertebrates (shredders). Leaf litter is an important source of organic C especially for small wooded streams.

In order to understand the role of shredders in processing of leaf litter in running waters two types of experiments were designed, in situ experiments in streams with different degree of anthropogenic impact using leaf litter bags with *Alnus incana* on one hand and laboratory microcosms experiments where density and diversity/ dominance of shredders species were manipulated on the other hand. According with the structure and composition of the local communities, selected shredders species as *Potamophylax rotundipennis*, *Potamophylax nigricornis*, *Mesophylax impunctatus*, *Nemoura fulviceps*, *Gammarus balcanicus*, were used within microcosm experiments and the results have been correlated with those arrived from the "in situ" experiment in order to improve our understanding of the mechanisms underlining litter decomposition process. Further the contribution of shredders to leaf litter processing was assessed by taking into consideration the breakdown rates under different experimental conditions.

Thus, leaf litter mass loss varied between 38.53% and 93.81 % for *P. rotundipennis*, between 28.03% and 36.88% for *N. fulviceps*, and between 32.51% and 89.54% for *M. impunctatus* for different manipulated densities during a microcosm experimental time of 23 days. In situ % *A.incana* litter mass loss is lower than in laboratory microcosm and varied between 16.35% after 7 days and 36.32% after 21 days for reference streams and between 15,50% respectively 63.15% for impacted streams, with high nutrients content. In this way *A.incana* litter, as a food source, has been supported a more diverse invertebrate assemblages for longer time. Relationships between species/ populations could affect also nourishment behavior and shredders efficiency.

Finally there is an attempt to use the experimental results for assessing the role of shredders as service providing unit and to discuss the potential use of such data for the assessment of ecological status of the investigated lotic systems.

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Effects of macro-fauna species on temperate litter decomposition.

Veronique Vos (1), Matty Berg (2), Jasper van Ruijven (1), Frank Berendse (1)
(1) Nature Conservation Group Wageningen University, The Netherlands.
(2) Animal Ecology, VU Amsterdam, The Netherlands

The current worldwide biodiversity loss and its potential effects on ecosystem functioning have been the focus of many studies during the last two decades [1, 2, 3]. So far most studies focused on primary productivity of grasslands. Other important ecosystem processes, such as organic matter decomposition, and ecosystems have received relatively little attention. However, decomposition plays a key role in nutrient cycling as well as carbon sequestration and it directly affects both primary production and the food web structure of the ecosystem. So far, studies assessing the impact of litter diversity on decomposition have yielded mixed results, ranging from positive to negative relationships between diversity and decomposition. The inconsistency of these results may be partly caused by interactions with soil fauna, such as detritivores [4]. However, this hypothesis has not been fully explored. We performed a climate chamber experiment using four forest litter species, which differ in important functional traits. Monocultures, every possible combination of two-species mixtures and four-species mixtures of these litter species were combined with monocultures of the three most influential Dutch macro-detrivores. Control treatments (without detritivores) were also included. Preliminary results suggest that detrivores not only increase decomposition rate but also change the influence of litter diversity on the process (Fig. 1). Litter diversity seems to have a positive influence on decomposition rate only when fauna is added. These results suggest that previous ambiguous results of biodiversity effects on decomposition may have been caused by soil fauna interactions and this should be taken into account in further studies.

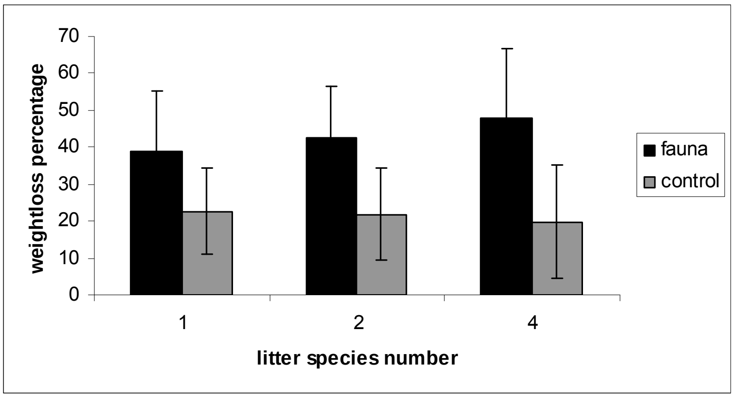

Fig 1: average weight loss (%) of litter during experiment for varying diversity treatments, with or without fauna added. The added fauna represents the average effect of the three detrivores.

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Do soil animals control litter diversity effects on decomposition in Mediterranean forests?

Tanya Handa (1), Tatiana De Oliveira (1), Benjamin Jackson (1,2), Jean-Francois David (1), Stephan Hättenschwiler (1)
(1) Centre d'écologie fonctionnelle et évolutive (CEFE-CNRS), 1919 route de Mende, 34294 Montpellier cedex 5, France
(2) Department of Forest Ecology and Management, Swedish University of Agricultural Sciences, 901 83 Umeå, Sweden

Plant litter diversity can be functionally important for decomposition and nutrient recycling. The underlying mechanisms for diversity effects, however, are poorly understood, in particular potential interactions across trophic levels. Large litter feeding soil animals might control litter diversity effects through altered food selection and consumption rates in response to changing litter species composition. In recent experiments using Mediterranean forest litter, we tested the interactions between changing litter diversity and macrofauna. Preliminary results suggest that leaf litter decomposition from individual tree species change in the presence of other species, and that macrofauna can strongly influence litter diversity effects on litter turnover and nutrient release. Our results suggest complementarity of detritivores within a single functional group (Diplopoda) and also in contrast with a gastropod species, where feeding habits strongly differ. We conclude that the interactions between litter species diversity and soil animals can have important implications for nutrient supply rates and may influence the fate of carbon and nutrient cycling in forest ecosystems.

How biotic interactions shape decomposition processes

Martin Zimmer
Christian-Albrechts-Universität zu Kiel, Zoologisches Institut; Am Botanischen Garten 9, 24118 Kiel, Germany

Besides physical processes such as fragmentation and leaching, decay through the activity of microbial communities and degradation through the joint action of microbes and detritivorous soil animals contribute to the decomposition of vegetal detritus. Since processes of fragmentation, leaching, decay and degradation affect, and depend on, each other, none of these processes can be considered alone. The comminution of detritus by feeding detritivores promotes both leaching and microbial decay that, in turn, increases the attractiveness of detritus as food for detritivores and their feeding activity. On the other hand, microbial biomass can be reduced by microbivory, whereas both selective feeding on senescent cells and dissipation of microbial propagules may promote the activity of the microbial community. Some microbivores may selectively feed on particular microbial taxa, leading to shifts in microbial community composition that, in turn, affects decay processes. Further complexity is added by the control of detritivore populations through predator activity. Owing to this complexity, our understanding of decomposition processes and how these are mediated through top-down and bottom-up control is still in a stage of infancy, despite decades of research in this area. Thus, it is mandatory to consider various functional groups and trophic levels of organisms involved, when studying the effects of biodiversity on decomposition processes.

Posterpresentations

The influence of tree species diversity on soil microarthropods: a litter exchange experiment

Stephanie Beyer, Nadine Fahrenholz, Sonja Migge-Kleian, Christian Platner, Matthias Schaefer*
Georg-August-University of Goettingen, Ecology Group, Institute of Zoology and Anthropology, Berliner Str. 28, 37073 Goettingen, Germany, Contact: sbeyer@gwdg.de*

The Hainich National Park is a large area of typical European deciduous mixed forest. Besides beech-dominated stands, mixed stands occur frequently with up to ten tree species on a local scale. The density of saprophagous soil macrofauna is high and its diversity increases with increasing tree species diversity. Soil microarthropods are strongly influenced by soil macrofauna especially earthworms but also depend on litter as food and habitat resource. The aim of the study was to differentiate between short term effects of litter input and long term effects of soil and soil macrofauna on microarthropod densities, diversity and species composition.

We investigated the oribatid mite community and densities of gamasid mites and collembolans in stands of three different levels of tree diversity (low, medium, high). Within each level of tree species diversity a litter exchange experiment was conducted with single litter species (beech, lime, ash) and litter mixtures (beech-lime-ash, beech-lime-ash-hornbeam-maple) corresponding to the natural canopy litter composition of the sites. Soil microarthropods were heat-extracted from soil samples (5cm ID) which were taken from each litter treatment of each diversity level.

First results show that in stands with highest tree species diversity, densities of soil inhabiting oribatid mites were generally 50 – 600% higher in all treatments compared to densities in litter samples. This is probably due to harsher microclimatic conditions in the litter of this early spring sampling. The difference between litter and soil was less pronounced in ash treatments where also densities were higher compared to the controls indicating that high quality litter enables litter colonisation despite dry conditions.

In all but the control treatments, mean species richness also differed strongly between litter and soil. Highest values were found in soil under pure ash where the community structure of oribatid mites was different compared to other treatments. These results underline the positive influence of this litter type on soil inhabiting oribatid mites.

Our study indicates that not tree species diversity alone influences the microarthropod community but rather that the dominance of single keystone tree species plays an important role for microarthropod species richness and community structure.

Is there a relationship between riparian tree richness and aquatic invertebrate and fungal communities?

Ferreira V. (1), Castela J. (2)*
(1) IMAR – Instituto do Mar, Universidade de Coimbra, 3004-517 Coimbra, Portugal
(2) Depto. Zoologia, Universidade de Coimbra, 3004-517 Coimbra, Portugal
** veronica@ci.uc.pt*

The connectivity between aquatic and terrestrial systems is particularly intense in the case of small woodland streams and adjacent riparian areas. This makes the aquatic communities and processes potentially sensitive to changes in riparian vegetation, like the anthropogenic induced decrease in species richness. A reduced riparian richness is expected to result in reduced invertebrate and fungal species richness, by means of reduced benthic litter richness. To see if this is the case, we surveyed 10 woodland streams in Central Portugal, during autumn 2006, regarding their riparian species richness, water physico-chemical parameters and channel morphology. Additionally, in each stream, we collected 10 Surber samples of benthic litter and invertebrates (litter richness, quantity and quality and invertebrate abundance and diversity) and sampled 3x500ml water for aquatic hyphomycete conidia in suspension. No relationship was found between riparian species richness and benthic species richness or quantity (linear regression, $p>0.193$). Conidia density in water was positively related with %riparian tree species, benthic litter richness and %N:%P (linear regression, $p<0.047$). Conidia species richness was positively related with riparian tree richness, water alkalinity and pH (linear regression, $p<0.029$). PCA analysis of fungal communities ordinated streams along a gradient of riparian woody species richness, alkalinity and catchment area (linear regression, $p<0.035$). Invertebrate abundance was positively related with benthic species richness (linear regression, $p=0.035$), invertebrate density with benthic litter mass ($p=0.018$), invertebrate taxa richness with riparian tree species richness ($p=0.027$), invertebrate biomass with benthic litter mass and riparian species richness ($p<0.050$), and PCA analysis ordinated the invertebrate communities along a gradient of benthic litter quality ($p=0.024$). The positive relationship between aquatic communities' parameters and benthic litter parameters may be explained by an increase in habitat availability (niche complementarity hypothesis). The mechanism behind the relationship between aquatic communities' parameters and riparian vegetation richness is elusive as there was no relationship between riparian species richness and benthic litter parameters, although this could be a result of the sampling schedule. In conclusion, increased riparian species richness resulted in increased richness and production of aquatic communities, which lead us to advocate forestry practices which protect/restore diverse native riparian areas.

Functional diversity, litter-microbe interactions and decomposition in grasslands differing in land use

Dagmar Rubatscher (1), Michael Bahn (1), Heribert Insam (2), Katharina Wohlmuth (1), Ulrike Tappeiner (1) & Alexander Cernusca (1)
(1) Institute of Ecology, University of Innsbruck, Sternwartestrasse 15, 6020 Innsbruck, Austria
(2) Institut of Microbiology, University of Innsbruck, Technikerstrasse 25, 6020 Innsbruck, Austria

Litter decomposition is a key process in the carbon and nutrient cycling of ecosystems. So far little is known on relationships between the functional diversity of litter and that of microorganisms residing on the litter, and how they might affect litter mass loss. We examined effects of the functional diversity and composition of litter on in-situ litter mass loss and on microbial functional diversity and substrate utilisation in mountain grasslands differing in land use. Altogether 95 different litter mixtures comprising various fractions of leguminous and non-leguminous forbs, graminoids and dwarf shrubs and various leaf-to-stem-ratios were exposed on a hay meadow, a pasture and an abandoned grassland in the Austrian Central Alps. Physiological profiles of the litter microbial communities, based on utilisation patterns of 27 sole carbon sources, were generated using the MicroResp method. Changes in the functional composition of grassland litter affected both litter quality (C/N ratio, leaf/stem ratio) and the functional diversity of the microbial community residing on the litter. Litter mass loss was mainly determined by plant functional identity and litter quality, rather than the number of plant functional groups contained in the litter or the functional composition of the litter microbial community. Effects of the functional composition of litter on microbial functional diversity and substrate utilisation were most apparent for litter mixtures with a high C/N ratio exposed on the abandoned site. Observed non-additive effects of litter mixtures on microbial substrate utilisation were not reflected in litter decomposition. We conclude that in the first stages of decomposition litter mass loss is mainly determined by litter quality, rather than the functional composition of the litter microbial community.

The effect of inter- and intraspecific diversity of drosophilids on decomposition processes

Heike Schmitz, Thomas S. Hoffmeister
University of Bremen, Institute of Ecology and Evolutionary Biology, Leobener Straße, NW2, 28359 Bremen, Germany

In a world of increasingly fragmented landscapes where species diversity is additionally threatened by climate change, the effects of diversity on ecosystem processes become more and more relevant. Previous work has mainly focussed on the effects of species richness on ecosystem processes. However, fragmentation also impacts population sizes and thus intraspecific genetic variability. To date, the effects of biodiversity provided by genetic variability have rarely been studied on ecosystem processes. Here we study the effects of intraspecific and interspecific variability on decomposition processes, using a simple experimental system of drosophilid flies and an artificial medium, consisting of a carbohydrate source and live yeast. Drosophilids are an intriguing subject of study, since they coexist without resource partitioning. We thus ask whether complete redundancy prevails or whether variability affects decomposition processes. Isofemale-lines with a defined developmental time representing different genotypes of three different Drosophila species (*Drosophila melanogaster, D. subobscura and D. immigrans*) were used to elucidate the possible effects of diversity. In different treatments decomposition rates of resources were measured through combining larvae of different genotypes of those three species. The observed parameters are metabolic rates, C/N-ratios, and fitness parameter of the flies (length and weight of pupae, survival probability).

Tracing the diversity and distribution of fungal genes encoding laccase in a spruce forest soil

S. Theuerl (1), N. Dörr (2), Uwe Langer (1), G. Guggenberger (2,3) and F. Buscot (1)
(1) UFZ Helmholtz Centre of Environmental Research, Department of Soil Ecology, Theodor-Lieser-Strasse 4, 06120 Halle (Saale), Gemany
(2) Soil Biology and Soil Ecology, Institute of Agricultural and Nutritional Sciences, Martin Luther University Halle-Wittenberg, Weidenplan 14, 06108 Halle, Germany
(3) Present address: Institute of Soil Science, Leibniz University Hannover, Herrenhäuser Str. 2, 30419 Hannover, Germany

Envisage the effects of environmental changes like the reduction of current atmospheric nitrogen deposition which might not only alter nitrogen cycling but, due to the intimate link of nitrogen and carbon cycling also microbial processes related to soil organic matter (SOM) formation, transformation and cycling is a challenging task, as these terrestrial processes are of global importance. We used the experimental plots of the “Solling roof project” to explore the response of a specific soil inhabiting fungal group of a Norway spruce forest ecosystem to the manipulation of the mineral N content in precipitation water.

Since the decomposition of lignin, a recalcitrant aromatic plant litter compound, is particularly related to nitrogen supply, we studied the genetic potential of basidiomycetes for the production of oxidative exoenzymes, at different nitrogen levels. Within the fungal lignolytic exoenzymes, laccases *sensu stricto* are the most widespread extracellular enzymes. They catalyze the one-electron oxidation of organic and inorganic substrates coupled with the reduction of oxygen to water.

We have applied classical molecular biological methods for tracing the diversity and distribution of basidiomyceteous genes encoding laccase like multi-copper oxidase (LMCO) and combined these with measurements of phenol oxidase activities and chemical analyses of the content and decomposition grade of phenolic compounds and lignin.

The diversity of the LMCO genes was assessed by PCR amplification with specific primers on soil DNA extracts followed by cloning, sequencing and sequence analysis. Our results showed that for samples taken in spring 2006 in coherence with the phenol oxidase activity the diversity of LMCO genes decreased with soil depth. This result is also corroborated by the pattern of lignin decomposition as identified by a chemolytic method. In contrast, in autumn 2006 this pattern was only found on an unroofed plot without N manipulation while on the two roofed plots (with and without N reduction) the diversities of LMCO genes were almost constant within the soil profile. A principal component analysis (PCA) confirmed the horizontal stratification for the spring sampling and the strong roof effect for the autumn sampling. Additionally the PCA showed a weak and punctual gene community answer to the N deposition reduction of the upper horizons Oe and Oa for the spring sampling. In view of these results, we propose that the LMCO gene diversity reacts sensitively to fluctuating hierarchical environmental factors that may temporally overlap nutrient and N availability.

Influence of type of canopy and soil perturbation by wild boar on decomposition and humidity of leaf litter, and microarthopod colonization in a mixed forest in the western Pyrenees

M. Unzu,I. Balanzategi J. B. Imbert, J. C. Iturrondobeitia, F. J. Castillo
Universidad Pública de Navarra, Arrosadía S/N, 31006 Pamplona, Spain

We studied the effects of type of canopy and soil disturbance by wild boar on decomposition and humidity of *P. sylvestris* and *F. sylvatica* leaf litter, and colonization of the pine litter by microarthropods in a mixed forest. Fifty four litter bags (1.5-mm mesh, 5 g, n =3 per treatment) were incubated for 163 days under *Pinus sylvestris* and mixed (*P. sylvestris* + *Fagus sylvatica*) canopies, and soil patches attacked and not attacked by wild boar. Incubations were carried out in two plots (30 x 40m): one that had been thinned seven years before this experiment (P30) and an unthinned plot (P0). Litter weight losses were higher for pine litter (32%) than for beech litter (13%) despite the fact that humidity was significantly greater (14 %) in beech litter. This suggests that in this experiment litter quality has more relevance than litter humidity to explain weight losses. Globally, wild boar significantly reduced Olson's decomposition rate ("k") by 20%, but effects were more dramatic in P30 under pine canopy (68 % reduction) where digging was deeper than in other areas. Apparently wild boar was searching for *Pteridium aquilinum*'s rhizomes that reach highest quantities in this microhabitat. In pine litter, wild boar effects on microarthropods were scant suggesting high resistance and/or resilience to disturbance. Densities of Cryptostigmata (eg., *Adoristes ovatus*), Mesostigmata, Metastigmata, Neelipeona, number of Cryptostigmata species and diversity indexes (Shannon-Wiener and Simpson) were significantly higher under pine canopy than under mixed canopy, probably reflecting differences in litter humidity (27% higher under pine canopy). Overall, these results suggest: 1) differences in litter humidity, and microarthropod densities and diversity between types of canopy were not high enough to trigger differences in "ks"; 2) wild boar disturbance, probably through changes in soil chemistry, was the main controlling factor of decomposition rates in this experiment.

Litter decomposer's effects on invertebrate diversity and trophic interactions: termites in arid savannas

Sara N. de Visser (1), Bernd P. Freymann (1), Hans Schnyder (2) & Han Olff (1)
(1) University of Groningen, Community and Conservation Ecology Group, PO Box 14, 9750 AA Haren, The Netherlands
(2) Technische Universität München, Lehrstuhl für Grünlandlehre, D-85350 Freising-Weihenstephan, Germany

In tropical savannas termites (Insecta, Isoptera) are known as important litter decomposers as well as ecosystem engineers. Their mounds offer habitation to diverse taxa and feeding guilds of vertebrates as well as other invertebrates; a keystone role of termites that has not been properly quantified as yet. This field study explores the role of termitaria in determining invertebrate diversity and their potential trophic interactions. Our study shows great diversity of invertebrate orders present in the termitaria. With the use of $\delta^{15}N$ and $\delta^{13}C$ stable isotopes we infer that inquiline top predators do not feed directly on termites, but on other invertebrates within the termitaria that are termitophagous. Hence, within a single given mound we do not merely find a high diversity of trophically unconnected invertebrates, but we are also able to show in a quantitative way that inquiline invertebrates are part of a food web with the mound-building termites as the essential component. It provides evidence that termites play a keystone role in the system by providing habitat for a diversity of trophically interacting invertebrates.

Identification and sustainable use of ecosystem services

4.5. Biodiversity of different taxa, of different levels of biological organization and their response to environmental change

Simone Pfeiffer, Daniel Prati, Markus Fischer

Oral presentations

Aims, Achievements and Future of the Biodiversity Exploratories

Simone Pfeiffer (1), Elisabeth K.V. Kalko (2), Karl Eduard Linsenmair (3), Jens Nieschulze (4), Ernst-Detlef Schulze (4), Wolfgang W. Weisser (5) & Markus Fischer (1,6)
(1) University of Potsdam, Institute of Biochemistry and Biology; Maulbeerallee 1, 14469 Potsdam, Germany
(2) University of Ulm, Dep. Experimental Ecology, Albert-Einstein Allee 11, 89069 Ulm, Germany
(3) University of Würzburg, T.-Boveri-Institute for Biosciences, Am Hubland, 97074 Würzburg,Germany
(4) Max Planck Institute for Biogeochemistry, Hans-Knoell-Strasse 10, 07745 Jena, Germany
(5) University of Jena, Institute of Ecology, Dornburger Strasse 159, 07743 Jena, Germany
(6) University of Bern, Institute of Plant Sciences, Altenbergrain 21, CH-3013 Bern, Switzerland

The Biodiversity Exploratories have been established as research platform to study the complex relationships between land use changes, functional biodiversity and ecosystem processes. The DFG-funded long-term project works at three large-scale exploratories: the biosphere reserve Schorfheide-Chorin, the national park Hainich and its surroundings, and the biosphere area Schwäbische Alb.

This introductory talk will give a brief overview of the aims and the establishment of the exploratory infrastructure. The selection of the study plots in forest and grassland was based on inventory data for vegetation and soil as well as permits given by the land owners and environmental offices. All research activities are carry out parallel to regular land management by land owners representing a gradient of land use intensities from near-natural to intensively managed landscapes.

Up to now more than 150 scientists from 25 research institutes conduct observations and experiments on different taxa and biodiversity levels. A unique sampling design for all groups studying soil organisms and below-ground processes was applied to allow comparisons across taxa and ecosystem processes relevant to different soil organisms. At the same experimental plots a large number of above-ground taxa are currently assessed and experiments to exclude, add, attrack and observe species are set up. In addition, meteorological parameters will be recorded on 300 plots and remote sensing will be used to document vegetation structure on a landscape scale.

A data base specially designed by the data management group will apply international standards of data upload, long-term data storage and analysis. The web-based support given to coordinate field work activities and information transfer within the exploratory project enhances interdisciplinary cooperation of research groups across Germany.

A second call for contributing projects ends in June 2008. The successful applicants will join the exploratories in early 2009. This will further close the gaps of remaining questions concerning the functions of species and species interactions in ecosystems also relevant to society that relies on ecosystem services.

The effect of land use on phytodiversity in the Biodiversity Exploratories

Steffen Boch (1), Jörg Müller (2), Stephi Socher (1), Henryk Baumbach (2), (1), Dominik Hessenmöller (3), Daniel Prati (1), Markus Fischer (1)
([1])University of Bern, Institute of Plant Sciences; Altenbergrain 21, 3013 Bern, Switzerland
([2]) Institute for Biochemistry and Biology, University of Potsdam
(3)Max-Planck-Institute for Biogeochemistry, Hans-Knöll-Str. 10, 07745 Jena, Germany

In geographically different regions of Germany three research sites for large-scale and long-term functional biodiversity research were established. One exploratory is situated at the Biosphere reserve Schorfheide-Chorin (NE Germany), one at the National Park Hainich and surrounding area (CentralGermany), and one in the Biosphere area Swabian Alb (SW Germany).

The aim of this study is to analyze (1) the impact of different land use types and intensities on phytodiversity in forests and grasslands and (2) how the diversities of different species groups (vascular plants, bryophytes and lichens) are correlated.

During the vegetation period 2007 and spring 2008, we sampled 1650 vegetation relevés (including 1100 bryophyte and 650 lichen plots) from different forest types with a plot size of 400 m². In grasslands we sampled 1600 vegetation relevés (including 765 bryophyte and 380 lichen plots) from different vegetation types with a plot size of 16 m². The plots were selected randomly stratified across land use gradients and we recorded all occurring taxa. For each plot we recorded the management regime, measured different structural parameters and estimated the coverage of the vegetation layers, bare soil, bedrock, litter and deadwood.

Vascular plant diversity was generally higher in managed than in unmanaged forests, most likely due to higher disturbance rates. Plant diversity was also higher in conifer than in deciduous forests, possibly due to the lower tree and litter cover in conifer forests. While total plant diversity was higher in managed forests, the amount of typical forest understorey species was significantly higher in unmanaged and deciduous forests.

Bryophyte diversity was positively correlated to vascular plant diversity in some forest types of the Hainich and Schorfheide exploratories. We generally found no relationship between the diversity of lichens and vascular plants.

In grasslands we recorded the highest vascular plant diversity per plot in the Swabian Alb. In generally non fertilized grasslands showed higher vascular plant density than fertilized, possibly due to a lower degree of competition. Bryophyte and lichen diversity was positively correlated to vascular plant diversity.

Large mammal diversity in relation to landscape structure

Eric Heinze, Stefan Halle
Institute of Ecology, Friedrich Schiller University Jena

Spotlight counting was conducted to get information about the diversity of large mammals in the Biodiversity Exploratories and the distribution in different forest habitats. The surveys were done in the Exploratories *Schwäbische Alb*, *Hainich-Dün*, *and Schorfheide Chorin* two weeks each in February/March 2007, October/November 2007, and February/March 2008. Tracks were chosen by taking forestry roads through various forest and edge habitats. The overall tracks had a maximum length of up to 40 km.

In the Exploratory *Schwäbische Alb* (South Germany, 48° 24′ N; 9° 29′ O) the track was mainly dominated by coniferous forest, some deciduous forest, as well as various open land habitats (farmland). Forest areas were patchily distributed in this region. The track in the *Hainich-Dün* Exploratory was following the "*Rennstieg*" trail (51° 12′ N; 10° 27′ O), passing through the National Park Hainich. The habitats along the track were dominated by deciduous forest, and contained very little open land. In the Exploratory *Schorfheide Chorin* (80 km north east of Berlin, 52° 54′ N; 13° 52′ O) habitat diversity was highest along that track, containing forests with beech, oak, pine, larch, and wetlands.

During daytime an estimate of the visibility conditions was done by recording the maximum sighting distance for each habitat type. Surveys started at 8:00 pm, and were conducted by slowly driving along forestry roads with a 4x4 vehicle, counting all observable animals. We used two fixed spotlights (50Watt), and two mobile spotlights (100Watt). The counting index of each species was computed by calculating the counted animal number per 100 ha sighting area.

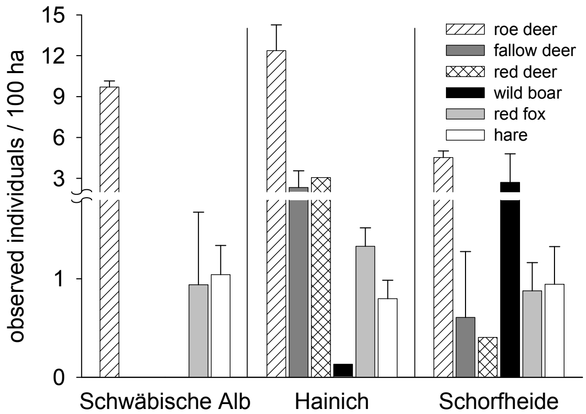


Figure 1: Counting indices of sighted species for all three Exploratories

Counting indices varied in a wide range but were most reliable for the large deer species. Fallow deer and red deer could not be seen in the Schwäbische Alb, since they are not present in this area. Although wild boar was evidently present in all three regions, numbers could not be verified with the used method. Touristic activity was highest in the Schwäbische Alb, medium in the Hainich, and lowest in the Schorfheide. Hence, it seems that wild boar reacts very sensitive to any kind of disturbance. Observed counting indices should be negatively correlated to the local hunting regime (shooting rate), and positively correlated to the presence of suitable habitat providing food resources and shelter. Beside the counting index we computed the Jacobs Index for all species containing the relative distribution of different habitats along the track and the probability of the specie´s counting events.

Do bees suffer disproportionally from land use intensification?

C.N. Weiner, M. Werner, A. Hilpert, K.E. Linsenmair & N. Blüthgen
University of Würzburg, Department of Animal Ecology and Tropical Biology*, Biozentrum,*
Am Hubland, 97074 Würzburg, Germany, c.weiner@biozentrum.uni-wuerzburg.de

The relationship between resource availability and biodiversity of consumers has gained particular attention with the increasing loss of species and habitats in recent decades. In this study we evaluated resource availability and resource quality of extensively and intensively used meadows for flower visiting insects, focussing on bees. While extensively used meadows were mown once a year, intensively used ones were mown 2-3 times and fertilized more heavily. We wanted to test whether intensively used meadows offer significantly less flowering plants than extensively used ones.

Between May and August 2007, a total of 40 meadows were studied, simultaneously sampling one extensively and one intensively used meadow (pair-wise design). Plots were randomly selected from a pre-selection of plots forming part of the DFG funded Biodiversity Exploratories. All actually flowering plant species and all flower-visiting bee species were recorded on 1000 m² area per plot during a six hour transect walk. Resource availability was defined as total number of flowering units per plot. Ten plot-pairs were sampled before the first mowing and ten pairs 1-2 months afterwards. Resource quality was measured as pollen amount and pollen amino acid composition of plant species.

Our results showed a significantly higher number of plant species on extensively used meadows before and after mowing. However, neither Simpson's diversity index nor the number of flowering units per site differed significantly between both land use types. Differences between meadows were more subtle, as both land use types differed in plant species composition and hence available resource quality. Several flowering plant species were exclusively recorded in extensively used meadows. Similar results were found for bee diversity and abundance that as well did not vary between land use types while species composition shows differences. Additionally, only five oligolectic species with a total of 17 individuals were found on the two land use types. They represent only 2.7 % of total bee individuals found. Nevertheless, the difference in plant species composition may play an important role to bee diversity and species composition, as bees need peculiar plant species for self supply and raising their brood.

Interaction networks: how specialized are pollinators in meadows with different flower availabilities?

Nico Blüthgen
University of Würzburg, Department of Animal Ecology and Tropical Biology, Biozentrum, 97074 Würzburg, Germany. Email: bluethgen@biozentrum.uni-wuerzburg.de

The literature on ecological networks provides different tools and metrics to describe associations between species, e.g. plant–animal or predator–prey interactions. Several recent studies focused on flower-visitor networks, because they involve an important ecosystem function (pollination) and are relatively easy to sample. Such 'pollination webs' were shown to have a 'nested' structure with asymmetric interaction strengths. These features have been suggested to promote the stable coexistence of species – specialists are assumed to preferentially associate with generalized partners and thus maintain a stable association. However, nestedness and asymmetric interaction strengths are already expected when common and rare species interact randomly, suggesting this pattern may not indicate variation in specialization rather than frequency. In any pollination web, some plants and some pollinators are frequent, while others are rare or even recorded only once. Not surprisingly, virtually all pollination webs are 'nested' and 'asymmetric'. Randomized webs with the same uneven abundance distribution are similarly or even more nested.

Based on an alternative approach to study specialization based on information theory, we show that pollinator webs are less nested than expected by chance. Specialists do not preferentially associate with generalist partners, but interact more symmetrically with other specialists. This high degree of mutual specialization holds for various meadows studied in the Biodiversity Exploratories, where specialization of hoverflies, bees and butterflies was similar between extensively used, species rich meadows and intensively used poorer ones. This finding suggests a much higher mutual dependence between pollinators and plants and a lower level of redundancy among species of the same guild than previously assumed.

Interacting effects of insect herbivory and mechanical disturbance on the vegetation structure in an old-field

Claudia Bräuniger (1), Martin Schädler (2) & Jutta Stadler (1)
(1) Helmholtz Centre for Environmental Research – UFZ, Theodor-Lieser Str. 4, 06120 Halle, Germany
(2) University of Marburg, Karl-von-Frisch-Str. 8, 35043 Marburg, Germany

Insect herbivory and mechanical disturbances change the structure and dynamics of plant communities, mainly by their effects on the competitive regime. Both factors are suggested to interact and should be analysed simultaneously.

In this study, we investigate from 2005 to 2007 possible interacting effects of above- and below-ground insect herbivory and disturbance intensity on the plant community structure of a naturally developed old-field (last crop: corn, ploughing and harrowing in autumn 2004). The experiment takes place on an experimental field near Halle/Saale (Saxony-Anhalt, Germany) and is arranged in a randomised split-plot design (higher level of variability/mainplots: disturbance, lower level of variability/plots: insecticides).

Mechanical disturbance is applied once per year in summer to the mainplots in 3 intensities (no disturbance = 0% of mainplot area disturbed, intermediate disturbance intensity = 12.5% of mainplot area disturbed by artificial grubbing, high disturbance intensity = 25% of mainplot area disturbed). Within the disturbance treatment, insect herbivores are excluded by different types of insecticides (above-ground and below-ground exclusion of insects).

From our results from the first 3 years of succession we conclude:

- Disturbance has no effect on phytophagous insects but reduces predacious arthropods at intermediate disturbance intensity at the beginning of succession.

- Regarding the interactive effects of insect herbivory on vegetation, phytophagous insects increase plant species richness at both disturbance intensities and decrease aboveground biomass only at high disturbance intensity (**Figure 1**).

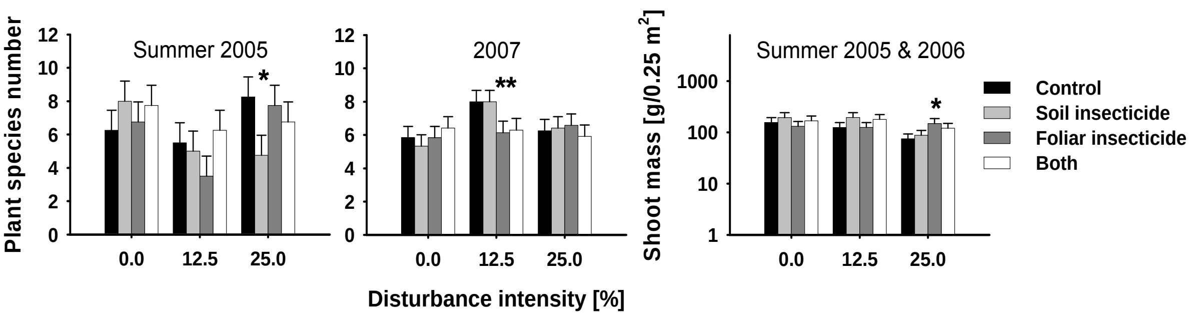


Figure 1 Interacting patterns of insect exclusion and disturbance: In the very early stage of succession, below-ground insect exclusion causes a significant decrease in plant species number at high disturbance intensity, in 2007 above-ground insect exclusion has the same effect at intermediate disturbance intensity (means of plant species number ± standard error). The interacting effect of disturbance and above-ground insect exclusion yields an increase in shoot mass compared to the control at high disturbance intensity (log10-transformed means ± standard error). Note that the y-axis is log-scaled. Significance (p) levels of the effects in relation to the untreated control are denoted with * $p<0.05$, ** $p<0.01$.

Alpha-, beta- and gamma-diversity of epigeic arthropods in grasslands under land-use change

Henriette Dahms (1), Sabine Mayr (1), Matthieu Chauvat (2), Klaus Birkhofer (1), Elvira Melichnova (1), Volkmar Wolters (1), Jens Dauber (3)
(1) Dep. of Animal Ecology, Justus-Liebig-University, Heinrich-Buff-Ring 26-32, 35392 Giessen, Germany
(2) Lab. of Ecology, ECODIV EA 1293, University of Rouen, FR-76821 Mont Saint Aignan cedex, France
(3) Trinity College Dublin, School of Natural Sciences, Botany, Dublin 2, Ireland

Land-use change in Europe is mainly driven by two opposing tendencies which generally both result in a decline of biodiversity: intensification of the management in areas favourable for agriculture vs. abandonment of traditional farming in regions with unfavourable conditions. The study presented here was carried out in the rural district of Northeim (Southern Lower Saxony; Germany), a region, where areas exposed to one of these trends alternate on a fine spatial scale. We distinguished grasslands threatened by abandonment ('extensive'; i.e. located at higher altitudes and on slopes with poorer soils, surrounded mainly by forest: n=15) and by intensification ('intensive'; i.e. located on richer soils and surrounded mainly by arable land: n=17). We compared the contribution of those grassland classes to the regional diversity of four epigeic arthropod taxa (ants, ground beetles, spiders and springtails). The regional diversity (γ) was partitioned into species richness per site (α-diversity), diversity between all investigated sites (β_{site}), and diversity between intensive and extensive grasslands (β_{class}). The β-diversity components generally accounted for the largest proportion of the γ- diversity. However, partitioning patterns of diversity components were highly taxon specific. All ant species and almost all Collembola species were found at the extensive sites, while the intensive sites hardly added to the regional species richness. In contrast, almost one-third of all carabid species was found exclusively in the intensive sites. Species turnover was largest for spiders, with both classes contributing equally to the regional species richness. Our results indicate that there is no consistent response of different components of biodiversity to land-use change in grasslands. This has implications for strategies aiming at the conservation of biodiversity and ecosystem services. Thus, future agri-environmental schemes should account for fine scale heterogeneity in land use and resulting differences in tendencies of land-use change.

Use of habitat affinity indices in measuring the short-term success of grassland reconstruction

Eszter Déri (1), Tibor Magura (2), Szabolcs Lengyel (3) & Béla Tóthmérész (3)
(1) Department of Evolutionary Zoology and Human Biology,(3) Department of Ecology, University of Debrecen; 4032 Debrecen, Egyetem tér 1., Hungary
(2) Hortobágy National Park Directorate
** e-mail: d_eszter@yahoo.com*

The disappearance of native grasslands caused by agricultural intensification is often addressed in practical conservation by converting arable lands to grasslands. Here we present a study of grassland reconstruction taking place in Hortobágy National Park, E-Hungary. This region has a significant role in the conservation of two Natura 2000 priority habitat types (Pannonic loess steppic grasslands and alkali grasslands and marshes). Our goal was to monitor the short-term effects of this grassland reconstruction using arthropod communities. We used both species richness and habitat affinity indices, based on fidelity and/or specificity of the species, to compare the 'naturalness' of the restored fields with native grasslands. 344 species were collected and given affinity values in 2007 (true bugs: 99 species, vegetation-dwelling spiders: 82, carabid beetles: 67, ground-dwelling spiders: 66, and orthopterans: 30). Species richness did not show any differences, while habitat affinity indices proved to be useful in detecting the changes of arthropod communities during succession (Fig. 1). Irrespective of which index was used, arable lands and one-year-old restored grasslands had significantly lower values than two-year-old and native grasslands, and two-year-old restorations also showed significantly lower naturalness than native grasslands. These results show that naturalness of arthropod communities can increase rapidly by converting arable lands to grasslands, and in the same time underline the usefulness of habitat affinity indices, often neglected in such studies.

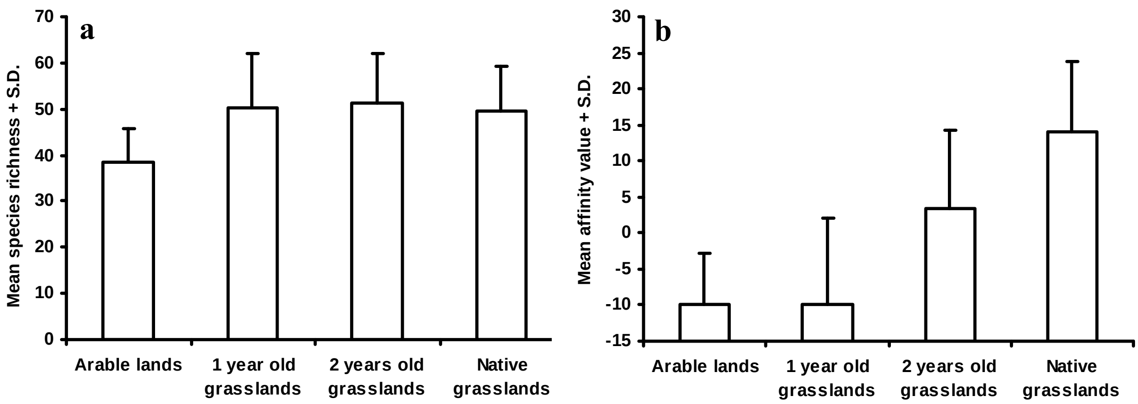


Figure 1: Changes in average species richness (**a**) and habitat affinity index values (based on both fidelity and specificity) (**b**) by the ageing of habitats. Species richness shows no significant differences ($F_{3, 39} = 1.93$, $p = 0.14$), while the habitat affinity index (HAFS) is significantly higher in native grasslands and two years old grasslands than in the other two habitats, and there is a difference also between native grasslands and two years old grasslands ($F_{3, 39} = 152.91$, $p < 0.001$).

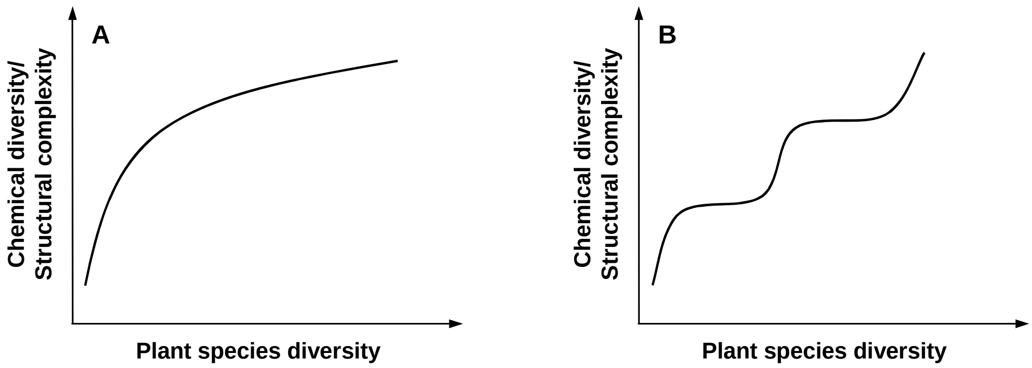
Vegetational complexity – influence of plant diversity and vegetation structure on plant chemical diversity and arthropods

Torsten Meiners (1), Barbara Randlkofer (1,2) & Elisabeth Obermaier (2)
(1) Institut für Biologie, AG Angewandte Zoologie / Ökologie der Tiere, Haderslebener Str. 9, 12163 Berlin, Germany
(2) Zoologie III, Tierökologie und Tropenbiologie, Am Hubland, 97074 Würzburg, Germany

Two major traits of vegetational complexity are plant species diversity and physical structures of vegetation. The chemical diversity of plant volatiles perceived by arthropods within a habitat may be affected by both the number of plant species and vegetation structure that influences microclimatic conditions as well as distribution of volatiles. How do plant species diversity, vegetation structures and volatile chemical diversity act "in concert" on herbivorous and carnivorous arthropods in a habitat?

In this talk we give an overview on how (a) plant species diversity of a habitat can affect herbivorous arthropods and higher trophic levels, (b) vegetation structure *per se* impacts herbivores and their natural enemies, (c) plant species diversity and vegetation structure changes plant volatile diversity which in turn may strongly affect olfactory orientation by arthropods.

Three new hypotheses will be raised that predict possible relationships between plant species diversity, vegetation structure and plant chemical diversity (Figure 1).



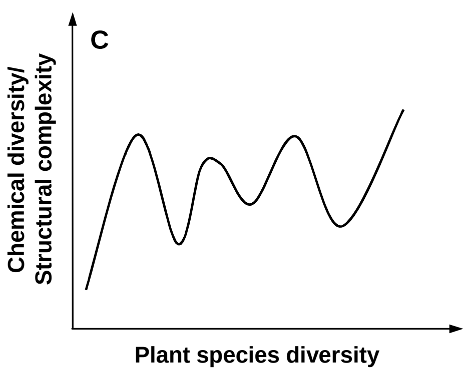


Figure 1: Proposed relationships of plant species diversity, structural complexity, and volatile chemical diversity within habitats of arthropods. (A) Continuous increase of diversity of volatile compounds and structural complexity with increasing plant species diversity. (B) Stepwise increase of volatile chemical diversity and structural complexity with increasing diversity of plant functional groups. (C) No direct correlation between volatile chemical diversity, structural complexity and plant species diversity.

Leaf functional traits of species from serpentine and non-serpentine soils

Elena Kazakou (1,2,3), Giorgos Adamidis (1), Andreas Troumbis (1), Panayiotis G. Dimitrakopoulos (1)
(1) Biodiversity Conservation Laboratory, Department of Environment, University of the Aegean, Mytilene, 81100, Greece
(2) Département Ecologie et Santé des plantes, SupAgro, 2 place Viala, 34060 Montpellier, France
(3) Centre d'Ecologie Fonctionnelle et Evolutive, CNRS UMR 5175, 1919 route de Mende 34293 Montpellier, France

Serpentine substrates are stressful environment for plant growth due to multiple limitations, collectively called the "serpentine syndrome": Serpentine soils are typically rich in magnesium and heavy metals, and poor in macronutrients, especially calcium. Adaptive responses to serpentine soil chemistry include mechanisms for coping with extremely low fertility, excessive concentrations of magnesium, and heavy metal tolerance. In this study we focused on species adaptive strategies for nutrient use and we tested the hypothesis that species from serpentine soils tend to have traits that allow them to use nutrients more efficiently than species from non-serpentine soils.

The study was conducted on 17 species occurring both in serpentine and non serpentine soils around Lesbos Island in Greece. Specific leaf area (SLA), leaf dry matter content (LDMC), leaf thickness (LT), leaf length and leaf width, were measured.

Variations for all the measured leaf traits were significant and pronounced. Species from non-serpentine soils tended to acquire resources rapidly than species from serpentine soils through a significant higher SLA, leaf length and leaf width. Species from serpentine soils tended to have traits that allow them efficient resource conservation (higher values of LDMC and LT). Our results support the contrasting "acquisitive" and "conservative" species strategies across serpentine and non-serpentine soils. Finally, we propose that measurements of leaf phosphorus (LPC) and leaf nitrogen content (LNC) would confirm and make our hypothesis more established.

Spiders diversity changes along the metal-pollution gradient in southern Poland

Sebastian Żmudzki, Irena Grześ, Paulina Kramarz
Institute of Environmental Science, Jagiellonian University; Gronostajowa 7, 30-387 Kraków, Poland

Metal pollution may cause considerable changes in community structure by the loss of the most sensitive species, leading to the decline in species richness and evenness. Spiders are considered one of the dominant macroinvertebrate predators group in terrestrial ecosystems [1]. Therefore, we tested the influence of metal pollution on spiders species diversity in the area affected by a lead-and-zinc smelter in Bolesław, southern Poland.

Two independent pollution gradients of increasing Zn pollution were established in wet and dry meadows. In total 12 sites were investigated; the distance from the pollution source was 0.6-32 km for the wet meadows and 3-32 km for the dry meadows. Sixty six pitfall traps traps were installed at each study site in the period from May through July 2005. The regression analysis for all sites showed that species diversity expressed as a hierarchical richness index HRI [2] decreased significantly with increasing total Zn concentration in soil ($p=0.016$). There was also a significant difference between wet and dry meadows in the regression intercepts ($p=0.007$), but not in the slopes ($p=0.391$, Figure 1).

The results show that metal pollution effected the spider communities negatively and that the effect was similar in wet and dry meadows.

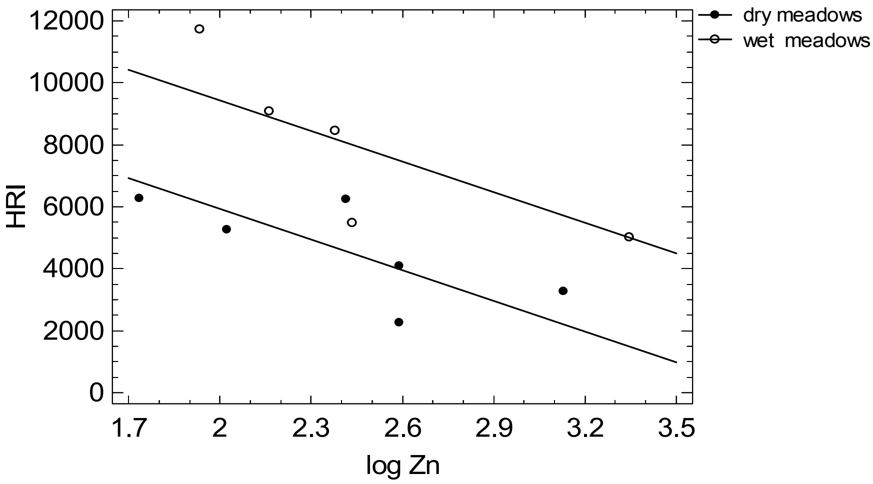


Figure 1: Effect of Zn contamination on hierarchical richness index (HRI) of spiders communities in wet and dry meadows

[1] Mac P., Canard A., Ysnel C., 1999. Spiders (Aranae) useful for pest limitation and bioindication. Agriculture Ecosystems & Environment 74: 229-273.
[2] French D., Lindley D., 2000. Exploring the data. In: Sparks T. (ed.). Statistics in Ecotoxicology. John Wiley & Sons Ltd, Inc., New Jork.

Does stability and biodiversity of microbial systems matter for degradation of environmental pollutants?

Robert Schäwe, Antonis Chatzinotas, Ingo Fetzer & Hauke Harms
Helmholtz Centre for Environmental Research- UFZ, Department of Environmental Microbiology, Permoserstr. 15, 04318 Leipzig, Germany

Microorganisms not only play an important role in ecosystems by driving biogeochemical circles but they also safeguard natural systems by breaking down man-made environmental pollutants. These services are often crucial for the bioremediation of polluted groundwater. In *constructed wetlands* high microbial diversity can be maintained, potentially resulting in optimal conditions for degradation of contaminated groundwater. However, as highly reliable remediation systems, *constructed wetlands* have to sustain their ability to breakdown pollutants even under varying environmental conditions and should readily recover after severe disturbances and resume breakdown. Theoretically it is assumed that a sufficiently high microbial diversity assures this ability. But is this biodiversity the driver of a stable function in such semi-artificial ecosystems?

We explore the degradation of groundwater pollutants in constructed treatment systems experimentally with the aim to investigate the effect of microbial biodiversity on the functional stability in *constructed wetlands*.

A reductionistic approach for addressing this issue was followed with laboratory model systems. The experimental setup included several bacterial communities, which were artificially composed to reach different biodiversity levels. The stability of these communities was tested by treatment with one or more external stimuli, like providing various levels of pollutants as stressors. Changes of structure and function as well as resilience after disturbance were regarded as a measure of stability.

It is shown that high diversity does not assure high stability under all conditions. At very high stress impacts, low diversity communities [can] show better functional stability.

Moreover, in this study we demonstrate that bacteria are suitable as model organisms for ecological questions. Hence, results of the ongoing experiments are not only of interest to bioremediation but furthermore contribute to the current diversity-stability debate.

Can plant diversity forecast the effects of land-use intensification in agro-forestry landscapes?

Ângela Lomba (1), Francisco Moreira (2), Joana Vicente (1), Paulo Alves (1) & João Honrado (1)
(1) Centro de Investigação em Biodiversidade e Recursos Genéticos (CIBIO) & Faculdade de Ciências, Universidade do Porto; Rua do Campo ALegre 1191, 4150-181 Porto, Portugal; angelalomba@fc.up.pt
(2) Centro de Ecologia Aplicada "Prof. Baeta Neves", Instituto Superior de Agronomia, Universidade Técnica de Lisboa, Tapada da Ajuda, 1349-017 Lisboa, Portugal

Agricultural landscapes occupy large portions of Europe and some are known to sustain high levels of biodiversity, so they are considered crucial for halting biodiversity loss in the continental territory. Current global changes are expected to promote dramatic changes in many rural areas, particularly through agricultural intensification. These changes will determine modifications in the spatial and temporal patterns of biodiversity, so in recent years much ecological research has been devoted to the identification of drivers and indicators, and to the development of models on which to implement scenarios of land use change.

In this research we present data from a survey of plant diversity in intensive agricultural landscapes related to dairy farming in Northern Portugal. Landscape mosaics along an agricultural intensity gradient were selected, analyzed concerning their land cover composition and spatial configuration, and results from those analyses were compared with a floristic dataset collected in each type of mosaic. Focal forest and agricultural patches were also sampled for their floristic composition in order to address patch-scale processes influencing community assembly and diversity patterns.

Globally, this research aims to assess how landscape features influence diversity indicators (e.g. species richness) and the overall floristic composition of agricultural landscape mosaics. At the landscape scale, we intended to address the following questions: i) How do landscape composition and configuration influence plant diversity across an intensification gradient? ii) Which biodiversity indicators can be used to forecast and monitor the impacts of agricultural intensification on plant diversity? At the patch scale, we aimed to evaluate the influence of surrounding landscape, with distinct levels of agricultural intensification, on patch-level plant diversity.

This study was financially supported by FCT (Portuguese Science Foundation), through PhD grant SFRH/BD/31576/2006 to A. Lomba.

Biodiversity response to forest management depends on taxonomic group: a meta-analysis in Europe

Yoan Paillet (1,2) & Laurent Berges (1)
(1) Cemagref, UR EFNO, 45290 Nogent-sur-Vernisson, France
(2) Cemagref, UR EMGR, 2 rue de la Papeterie, 38402 Saint-Martin-d'Hères, France

Among global changes, intensification of forest management is a major issue at the beginning of the 21st century – e.g. for bio-fuel production. Past and present pressures on forest resources have led to a drastic decrease in the surface area of unmanaged forests in Europe: they currently represent less than 1% of the total forest area (vs. 13% on the west coast of the United States and 40-52% in Canada). Modifications in forest structure, composition and dynamics inevitably lead to changes in the biodiversity of forest dwelling species. However, the possible gains and losses in biodiversity due to forest management have never been assessed at a pan-European scale.

In the current study, carried out within the framework of ALTER-Net, we hypothesized that biodiversity was higher in unmanaged forests although we expected contrasted responses for different taxa and ecological groups. We also identified the gaps in the knowledge concerning the response of biodiversity to forest management in Europe. We used a meta-analytical approach to do this. Meta-analysis is a quantitative review of the literature that combines the results of several independent studies examining the same question. Meta-analysis output accounts for the fact that all the studies are not equally reliable. In this study, we used species richness as a simple, though imperfect, index of biodiversity. The term "forest management" encompassed any anthropogenic pressures related to direct forest resource use (clearfelling, selective felling, any form of tree retention, grazing, planting or drainage). We analysed 51 published papers containing 122 individual comparisons of species richness between unmanaged and managed forests throughout Europe.

Species richness was slightly higher in unmanaged than in managed forests but the difference was only marginally significant. However, when we divided the studies according to taxonomic and/or ecological groups, we found both contrasted and more significant responses: (i) bryophytes, lichens, fungi and saproxylic beetles, which mainly depend on deadwood and/or large trees, were penalised by forest management; (ii) on the contrary, vascular plants were favoured by forest management; (iii) the response for carabids or birds was unclear and probably depends on other factors not included in our analysis (e.g. landscape patterns). This study also highlighted the need for more research, especially in temperate and Mediterranean regions and/or for some groups such as mammals or soil invertebrates.

To our knowledge, this study has been the first to compare biodiversity in managed and unmanaged European forests using meta-analysis. The conclusions of this study support an active conservation policy, creating new unmanaged forest reserves and encouraging management methods that mimic natural forest dynamics and structures. These actions would contribute to achieving the 2010 biodiversity target. Moreover, we suggest the creation of a coordinated European research network to study and monitor biodiversity of different taxa in managed and unmanaged forests.

Landsman or urbanite – how species traits and affinity to urban land-use control plant species frequency

Sonja Knapp (1), Ingolf Kühn (1)& Christine Römermann (2)
(1) Helmholtz-Centre for Environmental Research – UFZ, Department of Community Ecology; Theodor-Lieser Str. 4, 06120 Halle, Germany
(2) University of Frankfurt, Institute of Physical Geography; Altenhöferallee 1, 60438 Frankfurt, Germany

Although urban areas only occupy around 2.8% of the earth's land surface, urbanization threatens biodiversity as areas of high human population density and high biodiversity coincide. Rare plant species are especially endangered by urbanization, while more common plants might even profit from urban land-use. Protecting rare plants not only in rural but also in urban areas is an important contribution to the protection of biodiversity. We therefore need to understand why species are rare.

Studies on the causes of rarity often concentrate on either plant traits or extrinsic threats, e.g. fragmentation or nitrogen enrichment. There are however, only a few studies on the rarity of plant species combining intrinsic threats (e.g. having a more extinction-prone trait) and extrinsic threats, although such analyses might clarify causes of rarity. We calculated the relative frequency of vascular plant species in Germany, i.e. the actual frequency corrected for habitat frequency based on the 130 km² grid-cells from FLORKART. The interactions of functional traits and the affinity of plants to urban land-use explained relative frequency in generalized linear models, controlling for phylogenetic relatedness.

The higher the affinity of a plant species to urban land-use was, the higher was its relative frequency. The affinity to urban land-use interacted with the species' habitat preferences regarding moisture and temperature and with the type of reproduction (Fig. 1). Most traits (e.g. being anemochorous, hemerochorous, a neophyte or a hemicryptophyte) influenced relative frequency independently of the affinity to urban land-use. However, the interactions clearly increased the fit of the models.

Our results indicate that many rare species might already have disappeared from urban areas and show the potential of analyses combining intrinsic and extrinsic threats for understanding the causes of rarity to derive better conservation strategies.

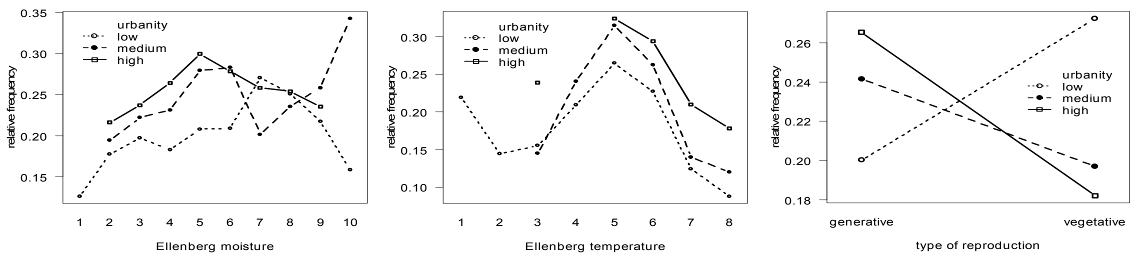


Figure 1: Interactions between the affinity of plants to urban land-use and Ellenberg moisture with values 1 – 10 corresponding to dry – wet habitats; Ellenberg temperature with values 1 – 8 corresponding to cold – hot habitats; type of reproduction. Lines were included for a clear illustration, but were only shown when no value in-between two other values was missing. The affinity of plants to urban land-use was calculated as Pearson's r for species occurrence and intensity of urban land-use per German grid-cell. Relative frequency was arc-sin transformed.

Linking root traits to microbial diversity and activity

Catherine Roumet, Sandrine Bioulac, Alain Blanchard, Nathalie Fromin, Eric Garnier
Centre d'Ecologie Fonctionnelle et Evolutive, UMR 5175, CNRS, 1919 Route de Mende, 34293 Montpellier cedex 5

Plant species identity influences the rhizospheric microbial community suggesting that the quantity and the quality of plant tissues and exudates is species dependant. The amount and quality of organic compounds released in the rhizosphere is highly dependant on root structure and activity. Because annual and perennial species differ in a large set of root traits involved in root litter quality, turnover, decomposability and rhizodeposition, we hypothesised that i) the high quality of annuals root litter stimulates the growth and activities of the microbial community leading to enhanced soil activities, and ii) root morphological traits may explain how individual species affect soil communities and soil processes.

Seventeen Mediterranean annual and perennial species were grown in monocultures in a common garden experiment. After three years of growth, soil cores were taken in each monoculture during the growing season. Root traits were measured and the effect of species on soil microbial diversity and activities was assessed using Biolog EcoPlate, assays of soil potential respiration (SIR), nitrifying (NEA) and denitrifying (DEA) enzyme activities.

Annuals exhibited less biomass per unit of soil volume than perennials; their roots had a high specific root length (SRL) and nitrogen concentration (RNC) but a low tissue density (RTD) and diameter as compared to perennials. Contrary to our hypothesis, the number of substrates oxidized and the catabolic activity were lower in annual monocultures than in perennial ones, while SIR, NEA and DEA were insensitive to life history. Interspecific differences in the number of substrates used and in catabolic activity were negatively correlated with the specific root length and positively correlated with the root tissue density. These results demonstrated that microbial communities and root traits are strongly associated and suggested that perennials as compared to annuals released i) more organic compounds, certainly because of their larger root biomass and their longer life cycle ii) a larger range of organic compounds, which might be associated to the presence of more recalcitrant compounds allowing root persistence and resistance.

The distribution of phylogenetic diversity of Mexican mammals

Ena Mata-Zayas (1) & Miguel Franco (1)
(1) University of Plymouth, School of Biological Sciences; Drake Circus, Plymouth PL4 8AA, United Kingdom

Mammals are an ecologically and evolutionary important group of organisms and their conservation is of paramount importance worldwide. Mexico has the second highest number of mammal species in the world [1]. Their variety of lifestyles and their distribution in every ecosystem makes them an ideal biodiversity indicator. Employing the country-wide mammal database (128,114 records) compiled by the Mexican National Commission for Biodiversity (CONABIO), we quantified the geographic distribution of mainland mammal diversity (416 species in 12 orders, excluding marine and insular species) in each of 749, 30’×30’ latitude by longitude cells. From literature data we constructed the phylogeny of the group. Armed with this phylogeny, we calculated two indices of phylogenetic diversity for each cell: Faith’s index of phylogenetic diversity [2] (*PD*) and Clark and Warwick’s index of taxonomic distinctness [3] (TD_{avg}). While *PD* measures the total length of the phylogenetic tree of those species found in a sample area (cell), TD_{avg} measures the average distance between a pair of species in the area. Dividing *PD* by *S*, the number of species in the sample, a measure of average phylogenetic distance, PD_{avg}, can be obtained. By the same token, multiplying TD_{avg} by *S* provides an index of total taxonomic distinctness, *TD*.

As expected, PD and TD were highly correlated (r^2=0.97, n=657, p<0.001), indicating that, although employing different algorithms in their calculation, they measure the same property of the system. The generally-held view that TD_{avg} is independent of sampling effort is not supported. As with any random sample subject to the Central Limit Theorem, the error in the estimation of the mean is dependent on sample size, in this case the completeness of records in an area. A complementarity analysis demonstrated that all 416 mammal species can be protected in 51 out of the 749 areas. Currently, only 18 of these 51 areas contain nature reserves. Taking other criteria into account (endemicity, threatened species, deviation of PD/TD from their expected value given their number of species), a further 34 priority areas for conservation were identified. The need to establish nature reserves in as many of these areas as possible is stressed. The analysis of this large dataset highlights the limitations of studies that concentrate on small taxonomic groups and/or limited geographic areas. We are currently investigating the link between the phylogenetic diversity of producers (vascular plants) and consumers (mammals).

[1] Mittermeier, R.A., Robles-Gil, P. & Goettsch-Mittermeier, C. 1997. Megadiversity: Earth’s biologically wealthiest nations. Conservation International and CEMEX. Washington D.C. 256 pp.
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[3] Clarke, K. & Warwick, R. 1998. A taxonomic distinctness index and its statistical properties. Journal of Applied Ecology 35:523-531.

Quantitative molecular population studies of single-celled eukaryotes reveal heterogenous population structures

Jens Boenigk, Barbara M. Auinger, Karin Pfandl
Institute for Limnology, Austrian Academy of Sciences, Mondseestr. 9, 5310 Mondsee, Austria
e-mail: jens.boenigk@oeaw.ac.at

Linking a specific protist or microalgal SSU rRNA sequence from environmental surveys to a specific morphotype is often problematic. Molecular surveys usually do not provide any information on the morphology of the organism whereas morphological surveys concentrate on preserved samples, which are usually not considered for molecular analyses. One main issue to overcome these problems is to link sequence analysis with morphological investigations from preserved plankton samples on a per cell basis. We present a method for quantitative analysis of planktonic protists and microalgae from field samples preserved with Lugol's iodine solution combining morphological and SSU rRNA gene sequence analysis. We will further discuss implications of molecular variation within chrysophyte populations. Our results indicate species-specific differences: the two species *Ochromonas* sp. and *Dinobryon divergens* were represented by several different genotypes each and for the latter species the dominating genotype differed with habitat. In contrast, *Dinobryon pediforme*, *D. bavaricum* and *Synura sphagnicola* were exclusively represented by a single genotype each and the respective genotype was the same in different samples. In summary, our results highlight the significance of molecular variation within protist morphospecies.

Underyielding in phytoplankton communities

Andrea Schmidtke, Ursula Gaedke & Guntram Weithoff*
University of Potsdam, Institute for Biochemistry and Biology, Department of Ecology and Ecosystem Modelling, Maulbeerallee 2, 14469 Potsdam, Germany
***** andrschm@uni-potsdam.de***

Species richness was shown to increase biomass production of plant communities. Such overyielding occurs when a community performs better than its component monocultures due to the complementarity and/or dominance effect. It was mostly detected in substrate-bound plant communities, e.g., terrestrial plants or submerged macrophytes, where spatial resource use complementarity may occur due to differences in rooting architecture and depth. Here, we analysed if these findings are generalizeable for free-floating phytoplankton communities exhibiting no direct neighbourhood relationships. We performed aquatic microcosm experiments with eight phytoplankton species belonging to four functional groups with different functional traits (non-motile chlorophyceae, non-motile and silicate-demanding diatoms, potentially N-fixing and filamentous cyanobacteria and motile cryptophyceae). The species were growing in nutrient-depleted WC medium for 21 days allowing approx. four generations. Due to a high functional redundancy within one functional group we hypothesized that overyielding does not occur within the group. On the other hand, an increasing number of functional groups within a community may lead to overyielding due to a higher resource use complementarity. We did not detect overyielding in any community. Instead, the community biomass decreased with an increasing number of functional groups. This underyielding was mainly caused by the negative dominance effect. The fast growing species with low monoculture biomass (*Monoraphidium minutum*) became dominant in all communities and exhibited overyielding at all functional diversity levels. The other, more slowly growing and mostly underyielding species (*Oocystis marsonnii*) had high biomasses in monoculture but lower ones in mixture. This inverse relationship between species biomasses in monoculture and mixture was attributed to a trade-off between growth rate and final biomass production in our experiment. In monoculture, slow growing species built up higher biomasses than fast growing species. In mixture, the fast growing species with a low biomass production presumably monopolised most of the nutrients, which prevented the other competing species from developing high biomasses as expected from their monocultures. When this trade-off between growth rate and biomass production occurs for free-floating algal species, overyielding is not be expected and resource use complementarity seems to be of minor importance. As a consequence, biodiversity-ecosystem functioning relationships may not be generalizeable from substrate-bound plant to phytoplankton communities and vice versa.

Effects of forest fragmentation and disturbance on biodiversity and ecosystem functions in an African rainforest

Matthias Schleuning (1), Nina Farwig (1), Arnhild Althof (2), Dana Berens (1), Thomas Bergsdorf (3), Bärbel Bleher (1), Alexandra Brenner (3), Helmut Dalitz (4), Eberhard Fischer (2), Georg Fischer (2), Wolfram Freund (3), Mary W. Gikungu (5), Robert Gliniars (4), Melanie Hagen (5), Paco Hita Garcia (3), Manfred Kaib (6), Jasper M. Kirika (1), Manfred Kraemer (5), Lars Kühne (3), Tobias Lung (7), Itambo Malombe (2), Nicholas Mitchell (7), Winfred Musila (4), Marcell K. Peters (3), Gertrud Schaab (7), Inge Theisen (2), Henning Todt (4), J. Wolfgang Wägele (3), Kumelachew Yeshitela (2) & Katrin Böhning-Gaese (1)
(1) University of Mainz, Community and Macroecology Group, Becherweg 13, 55099 Mainz, Germany
(2) University of Koblenz-Landau, Botany, Universitätsstraße 1, 56070 Koblenz, Germany
(3) Zoologisches Forschungsmuseum Alexander Koenig, Adenauerallee 160, 53113 Bonn, Germany
(4) University of Hohenheim, Faculty of Botany, 70599 Hohenheim, Germany
(5) University of Bielefeld, Biological Collection, PO Box 100 131, 33501 Bielefeld, Germany
(6) University of Bayreuth, Animal Physiology, Universitätsstraße 30, 95440 Bayreuth, Germany
(7) Karlsruhe University of Applied Sciences, Geomatics, Moltkestr. 30, 76133 Karlsruhe, Germany

Habitat fragmentation and degradation are important drivers of biodiversity loss, but little is known about their combined effects on the diversity of plant and animal taxa and on ecosystem functions like predation, dispersal and regeneration. Here, we present an analysis of the effects of forest fragmentation and disturbance on biodiversity and ecosystem functions in a tropical rainforest based on data collected in Kakamega Forest (Kenya) over several years. Forest fragmentation and disturbance did not affect the overall diversity of trees, birds, and rodents, while ant diversity decreased with forest disturbance. Species composition of trees and ants changed with distance from forest edge, while bird species composition differed between main forest and fragments. Ecosystem functions were also affected by fragmentation and disturbance. Lichen diversity decreased, but seed removal by frugivorous birds and predation by army ants increased with forest disturbance, while antbird predation and tree regeneration were lower in fragments than in the main forest. We conclude that different taxa respond differently to forest fragmentation and disturbance, whose effects on species composition are stronger than on diversity. Changes in community composition in response to human-induced habitat change are important because ecosystem functions are sensitive to the identity of the interacting species.

Woody species as landscape modulators: Their effect on the herbaceous plant richness in a Mediterranean maquis

Agra, Har'el (1) and Ne'eman, Gidi (1,2)
(1) Department of Evolutionary and Environmental Biology, Faculty of Science and Science Education, University of Haifa, Haifa 31905, Israel; E-mail agra10@bezeqint.net.
(2) Department of Science Education - Biology, Faculty of Science and Science Education, University of Haifa-Oranim, Tivon 36006, Israel; E-mail gneeman@research.haifa.ac.il

Organisms that modify habitats by changing the availability of resources for other organisms are 'Ecosystem Engineers'. 'Landscape Modulators' (LMs) are ecosystem engineers that have an impact on community structure by creating patches in the landscape mosaic, in which resource availability defers from that of the background area. Our aim was to study the effect of evergreen-trees, as LM, on local herbaceous plant species richness in a Mediterranean maquis system in northern Israel. The research site is located (35.25ºE, 33.15ºN) in the Upper Galilee, Israel; at an average altitude of 850 m. The bedrock is limestone, the soil is tera-rosa and average annual precipitation of 900 mm. The vegetation consists of *Quercus calliprinos*, *Pistacia palaestina* accompanied by *Quercus boissieri* and some deciduous Rosaceae. The vegetation forms dens maquis, with patches of herbaceous plants, which are green during winter and spring but dry during summer, separate the woody patches. The present research is part of a long-term ecological research (LTER) in Israel, which includes five study sites along the aridity gradient in Israel ranging from 50 to 900 mm of rain per year. A similar experimental protocol was applied in all LTER sites to examine the effect of woody LM canopy removal and grazing on species richness of several groups of organisms of various trophic levels. To do so we examined the effects of canopy removal and cattle grazing on herbaceous plant species richness, plant functional types and rare plant species. We applied factorial block design and measured herbaceous plant species richness in two patch-types: (1) Woody - under tree canopy (or the location of a removed canopy). (2) Herbaceous - not under any tree canopy.

The extreme negative effect of the woody patch on herbaceous plant species richness disappeared soon after the removal of the LM canopy. Patch type and tree removal affected HPSR and presence of plant functional types. Most important was the differential response of some rare plant species. We conclude that the dominant effect of the LM evergreen woody patch can be regulated by canopy removal and grazing for maintaining patch-type and landscape diversities. Preservation of woody and herbaceous patches, side by side, is essential for maintaining a high herbaceous plant biodiversity. The differential responses of the various plant functional types and the examined rare species to the treatments, demonstrates their possible use as management tools for the maintenance of high diversity in general and conservation of some rare species in particular. Intelligent use of various active management tools is needed for maintaining landscape diversity, coexistence of various successional stages of the woody LMs and patch-types side by side for the maintenance of the high biodiversity level in Mediterranean ecosystems, which is a main goal of current nature conservation policy.

Poster presentations

Fungi fruitbodies and soil macrofauna as indicators of land-use severity in cork oak woodlands

Anabela Marisa Azul (1), Sara Mendes, José Paulo Sousa & Helena Freitas (1)
(1) Centre for Functional Ecology. Department of Botany, University of Coimbra, 3000-456 Coimbra, Portugal
(2) IMAR. Department of Zoology, University of Coimbra, 3001-455 Coimbra, Portugal

We assessed fungi fruiting body and soil macrofauna diversity and abundance to estimate the impacts of management planning used to control shrub density in Portuguese oak woodlands dominated by *Quercus suber* (Montado). The study was conducted in four experimental stands, over 2-years sampling (2003 and 2004). The experimental stands include the control, with no shrub-cutting over the last 6 years (C) and no intervention during sampling period; the cut stand (Cu), where shrubs are cut each 5-years growth using heavy machinery without soil mobilization (shrubs were cut in the beginning of autumn of 2004); the cattle stand (Ca), where shrub density is controlled by the permanent presence of cattle (cows and sheep); and the mobilized stand (M), where shrubs are cut each 2-years growth, using heavy machinery and soil mobilization (shrubs were cut in the beginning of autumn of 2004). Experimental stands C, Cu, Ca and M were classified into severity levels, where C represents the control and M the technique more severe.

A total of 4881 fruitbodies were assessed in the four stands, 3131 fruitbodies in 2003 (114 species) and 1750 fruitbodies in 2004 (55 species). Abundance and species richness were highest in C and lowest in Ca and M stands. In the stand Cu fruitbodies abundance and species richness were similar to C during the autumn 2003, but decreased greatly in autumn 2004. Multivariate analysis clearly separated the C and Cu stands from the Ca and M stands in autumn 2003. The symbiotic fungi, *Laccaria laccata, Lactarius quietus* and *Xerocomus subtomentosus* were closely related with less disturbed stands (C and Cu), while the saprobes *Entoloma conferendum* and *Macrolepiota procera* were associated to Ca and M. Most species associated to less severe land-use techniques were present in C during the 2-years samling, but not in Cu after shrub being cut (in 2004). Regarding to soil macrofauna, 3667 individuals were caught in the traps, 1799 individuals (53 species and morphospecies) in 2003 and 1868 individuals (34 species and morphospecies) in 2004. In the first year, the highest values of taxa and species richness were obtained in C and Cu; the lowest values were observed in M. Multivariate analysis clearly separated the stand with machinery intervention. The ant species *Apahenogaster senilis* and several *Staphylinid* morphospecies were closely related to M, whilst most of spider families were directly associated to less disturbed areas. In the second year of sampling, higher values of taxa and species richness were observed in M and Ca. Invasive species caught in those areas explain the results. Species diversity, species richness and abundance within Cu and control were still identical during 2004.

Our data imply that fruiting body and soil macrofauna surveys are useful indicators of management planning in cork oak woodlands. Both fungi and soil macrofauna community composition were affected by land use practices. Shrub control using severe techniques lead to greater decreases in species richness and abundance of both groups of organisms. On-going studies will clarify which land-use practices allow species recovery and better promote ecosystem resilience.

Lichen diversity in the Biodiversity Exploratories

Steffen Boch (1), Dominik Hessenmöller (2), Daniel Prati(1), Markus Fischer (1)
(1) University of Bern, Institute of Plant Sciences; Altenbergrain 21, 3013 Bern, Switzerland
(2) Max-Planck-Institute for Biogeochemistry, Hans-Knöll-Str. 10, 07745 Jena, Germany

In geographically different regions of Germany three research sites for large-scale and long-term functional biodiversity research were established. One exploratory is situated at the Biosphere reserve Schorfheide-Chorin (NE Germany), one at the National Park Hainich and surrounding area (CentralGermany), and one in the Biosphere area Schwäbische Alb (SW Germany).

The aim of this study is to analyze (1) the impact of different land use types and intensities on the lichen diversity and the species composition (i.e. growth form, reproduction type), (2) the influence of spatial heterogeneity on the lichen diversity and (3) how the diversities of different species groups (vascular plants, bryophytes and lichens) are correlated.

During the vegetation period 2007 and spring 2008, we sampled 635 vegetation relevés from different forest types with a plot size of 400 m², and 379 vegetation relevés from different grassland types with a plot size of 16 m². The plots were selected randomly stratified across land use gradients, we recorded all vascular plants, bryophytes and lichens (including the epiphytic and non epiphytic taxa). For each plot we recorded the management regime, measured different structural parameters and estimated the coverage of the vegetation layers, bare soil, bedrock, litter and deadwood.

In forests we recorded a total of 200 lichen taxa. Species densities per plot varied between one and 53. Highest mean lichen species densities were found in the forests of the Schwäbische Alb (18.8), intermediate densities in the Schorfheide-Chorin (6.0), and lowest densities in the Hainich area (5.0). The lichen species densities in comparable forest types within one Exploratory varied slightly under different forest management regimes. The proportion of non-epiphytic taxa was significantly higher in the Schwäbische Alb than in the other areas due to plot heterogeneity and habitat diversity. We found no relationships between lichen and vascular plant diversity, but for some forest types we found a positive relationship between lichen and bryophyte diversity.

In grasslands we recorded a total of 111 lichen taxa. Species densities per plot varied between zero and 30. We found positive relationships between lichen vs. vascular plant and lichen vs. bryophyte diversity.

We will further apply regression analyses to evaluate the effects of land use, environmental conditions and forest structure on the lichen diversity.

Diversity of laccases and laccase like multicopper oxidases at the three German biodiversity exploratories

S. Christ (1,2), T. Wubet (2), F. Buscot (1,2), R. Daniel (3)
(1) University of Leipzig, Institute of Biology I; Johannisallee 21, D-04103 Leipzig
(2) UFZ-Halle, Department of Soil Ecology; Theodor-Lieser-Straße 4, D-06120 Halle
(3) University of Göttingen, Institute of Microbiology and Genetics; Justus-von-Liebig-Weg 11, 37077 D-Göttingen

Terrestrial carbon cycle involves decomposition and transformation of the bioavailable carbon pool bound as organic soil compounds. Degradation of plant litter is largely performed by soil microorganisms through secretion of oxidoreductase enzymes like lignin peroxidases, manganese peroxidases and especially laccases and laccase like multicopper oxidases (LMCO). Laccases and LMCOs are copper-containing enzymes catalyzing the oxidation of complex recalcitrant molecules particular phenolic substrates (e.g. lignin) coupled with the reduction of molecular oxygen to water. Recent studies showed a wide occurrence of fungal and bacterial laccases involved in the primary attack of recalcitrant soil organic matter [1] and also the presence of novel laccase genes in different habitats [2, 3].

We will present a project concept dealing with the analysis of diversity of laccase and LMCO genes through construction and screening of metagenomic libraries from soil samples along land use (forest vs. grassland) and land use intensity (extensive vs. intensive) gradients at three German biodiversity exploratories. Based on the fungal and bacterial laccase and LMCO gene diversity biochips will be constructed for further large scale analysis of spatial and temporal variations within and among the three biodiversity exploratories.

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The features of the biodiversity of a hydrographical basin (basins) from the Romanian Plain

Olivia Cioboiu
The Oltenia Museum Craiova, str. Popa Şapcă nr. 8, 200416 Craiova, Romania

The hydrographical basin is located within the Romanian Plain and the Danube River borders it in the South. Its main feature is the presence of thirteen small basins built along the Preajba Valley (a tributary of the Jiu). From the ecological point of view, the basins belong to the category of eutrophic ecosystems displaying a great flora and fauna diversity [2].

The structure of the phytoplankton, periphiton, and aquatic macrophites. There are 78 species in the phytoplankton and periphiton coenosis. The most numerous and constant species are *Achnanthes minutissima, Cyclotella chaetoceras, Nitzschia recta, Synedra acus* (diatomeea), *Pediastrum simplex* and *Scenedesmus quadricauda* (Chlorophyceae) and *Microcystis aeruginosa* (Cianophyceae) [4]. 20-30 percent of the surface of the basins is covered by the paludous and aquatic macrophites. There have been identified 34 species, among which we mention *Phragmites communis, Scirpus lacustris, Heleocharis palustris, Nimphaea alba, Potamogeton natans, Mentha aquatica, Myriophyllum spicatum, Ceratophyllum submersum*.

The zooplankton structure is represented by 65 species, the dominant ones being *Vorticella convallaria, Asplancha priodonta, Brachionus calyciflorus, Filina longispina, Keratella quadrata, Bosmina longirostris, Chydorus sphaericus, Acanthocyclops vernalis, Mesocyclops crassus* [3]. The zoobenthos comprises 13 large groups of invertebrates: Chironomidae, Gammaridea, Ostracoda, Heteroptera, Gastropoda, Bivalves, Cladocera, Copepoda, Ephemeroptera, Plecoptera, Isopoda, Oligochaeta, Hirudinea. The gastropods represent one of the most important components of these basins. There have been determined 18 species, the most frequent ones being *Viviparus acerosus, Esperiana esperi, Physella (Costatella) acuta, Stagnicola palustris, Radix ampla, Planorbis planorbis* [1]. The ichtiofauna is characteristic to the eutrophic lacustrine ecosystems including the following species: *Cyprinus carpio, Carassius auratus gibelio, Rutilus rutilus, Abramis brama*.

An important feature of this hydrographical basin is its location within a quite arid plain area from Romania. They have been built recently and they undergo the influence of the anthropic factors, which are essential elements for the structuring of the biodiversity of the specific ecosystems.

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When does a grove become a forest?

Ulrika Danzer, Patrik Dinnétz & Kari Lehtilä
Södertörn University College, School of Life Sciences, 14180 Huddinge, Sweden

Landscape structure varies substantially among countries in the Baltic Sea region and elsewhere in Europe. In Scandinavia, forests are continuous over large areas, while Central European forests are smaller and in many areas fragmented. Landscape configuration is likely to have an effect on plant distributions. Forest characters with large potential to affect plant incidence and distribution patterns are area and connectance but forest shape, forest age and forest structure are also likely to affect species distributions. The aim with this study is to test if different forest characteristics are correlated with plant species distributions. We will estimate species richness in coniferous forests of different size, connectedness, shape, age and structure in three larger regions in Sweden and in countries east and south of the Baltic Sea. The inventory information will be integrated with data from secondary sources, primarily from provincial floras. This will allow us to analyse distribution patterns at different spatial scales in relation to habitat structure. Our results can be used to test whether the mere quantity of suitable area is critical in limiting species distribution, and how habitat deterioration within suitable areas affects species distribution.

Relationship between pollution and fluctuant asymmetry in some *Fabaceae* species

Irina Neta Gostin
UniversityAl. I. Cuza Iasi, Faculty of Biology, Bdul Carol I, no 11, 700506 Iasi, Romania

Developmental stability measures are potential tools in monitoring environmental stress in plants. It is based on the organism's ability to minimize random perturbations during development and is often used as a measurement of the effects of environmental perturbations on organisms [1].

The degree of fluctuating asymmetry of a trait could depend on its functional importance, because a stabilised development should be more strongly selected in the characters performing critical functions for an organism, in which FA might be detrimental, than in those characters functionally less important [2].

Habitat quality refers to the ability of the environment to provide conditions appropriate for individual and population persistence. The quality of population habitat is, therefore, expected to negatively relate to environmental perturbations [4]. However, the main drawback of the use of FA as a diagnostic tool is the difficulty in discriminating the genetic from the environmental components producing FA in the field.

In this paper the developmental instability (DI), measured as fluctuating asymmetry (FA) of some *Fabaceae* species (*Lorus corniculatus, Trifolium pratense* and *T. repens*) growing in polluted and unpolluted sites was followed. This parameter was estimated and compared between three populations of each investigated species, two from areas with different pollution gradients and one from a clean area; leaf width (LW and RW, which is the distance from the midrib to the right and left margins) was measured from 30 leaves of individuals from each area and the rapport LW\RW was considered for FA determinations. Results obtained using both FA indices were the same: higher asymmetry levels were observed in unpolluted area than in pollutes sites. These data indicating that plants living in the stressful habitats are more symmetrically and consequently these three cosmopolite species could be use as an 'index of habitat quality.'

Parsons [3] has mentioned that relatively severe stress is needed to increase FA under field conditions. Increasing asymmetry tends, therefore, to occur in stressed marginal habitats. Genetic perturbations implying genomic stress include certain specific genes, directional selection, inbreeding, and chromosome balance alterations.

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Air pollution effect on some wooden angiosperms leaves

Irina Neta Gostin
University Al. I. Cuza Iasi, Faculty of Biology, B-dul Carol I, no 11, 700506 Iasi, Romania

Some biochemical and histological parameters of different species of superior plants, which may be considered as biomarkers, was investigated, in order to establish what modifications occur. The investigations were "case study" type and the information obtained could be tested consequently upon a larger amount of species. We have investigated following species wooden angiosperms: *Carpinus betulus, Tilia tomentosa, Salix fragilis, Populus tremula, Crataegus monogyna*.

The vegetal material was collected from National Park Ceahlau and this adjacent area. The control sample (M) was collected from the protected area of the park and the variants from Tasca village (V1) (near the cement factory), rail station Tasca (V2) and carrying station (V3). The stationary conditions (regarding air pollutants presents in the area) was obtained from Neamt Environmental Protection Agency.

In plants, the first reactions in abiotic stress were identified to be a fast and increased release of reactive oxygen species, as a result of decreasing amounts of molecular oxygen (O_2): superoxid anion (O_2-), hydrogen peroxide (H_2O_2) and hydroxyl-radical (HO-). The formation of ROS is prevented by an antioxidant system and enzymes regenerating the reduced forms of antioxidants, and ROS-interacting enzymes such as SOD, peroxidases and catalases [1]. In un-stressed vegetal cells this species are generated usually in low amounts in chloroplast and mitochondria or by cytoplasmic enzymes.

Biochemical analysis: The peroxidase and superoxide-dismutase (SOD) was investigated. The peroxidase activity increase in *Crataegus monogyna* (28.5134 U/ml V3) and *Salix fragilis* (28.1588 U/ml V3 and 23.1439 U/mlV2). This demonstrated that these species are the more sensible to pollution agents from this zone, these having the stressing effect on the metabolism of these plants. In the same time, the decrease in the activity of SOD, observed in *C. monogyna* leaves, indicated a sensibility of this species to the polluting agent, because of the inhibition of normal respiration and normal mechanisms of photosynthesis from the leaves. In the other analysed species the SOD amounts decrease slightly in polluted sites.

Histological analysis: In all investigated species leaves dark phenolic deposits could be observed. These compounds usually appear in plants exposed to air pollution [1]. These are located in all leaf tissues, frequently in mesophyll (palisade or spongy parenchyma), isolated or grouped. The phenolic compounds appear as result of metabolic changes in these tissues, because the epidermis remains intact. In the same sample, in different regions of the leaves large areas of necrosis could be observed. These resulted after the disintegration of the cells which accumulate the phenolic deposits. The number of stomata and the shape of the epidermis and stomatal cells show no significant variations between control and samples from polluted sites.

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CréBeo: the diversity and indicator value of soil micro- and macro-organisms in Irish soils

Aidan M. Keith (1), Bas Boots (1), Nick Clipson (1), Christina Hazard (1), Derek Mitchell (1), Fiona Doohan (1), Robin Niecho (2), John Breen (2), Christine Griffin (3,) Tom Bolger (1) & Olaf Schmidt (1)
(1) School of Biology & Environmental Science, University College Dublin, Ireland
(2) Department of Life Sciences, University of Limerick, Ireland
(3) Department of Biology, NUI Maynooth, Ireland

The CréBeo project aims to increase scientific knowledge and research capability in soil biodiversity, and to inform the development of policies and management guidelines compatible with national and EU soil protection strategies. Ireland has never had a sustained, systematic or large-scale research programme in soil biology, and no baseline data are available for any soil organism groups, apart from root pests and diseases.

The project has sampled sixty sites from the Irish National Soils Database reference locations to survey the occurrence, abundance and diversity of a wide range of soil micro- and macro-organisms (soil bacteria, mycorrhizal fungi, nematodes, microarthropods, earthworms, ants). The samples were selected from a matrix of land-use types (arable, pasture, rough grazing, forest and peat) and soil types (Acid brown earths, shallow brown earths, brown podzolics, grey-brown podzolics, gleys, lithosols and peat). This project has provided the first baseline data on the diversity and distribution of soil organisms in the soils of Ireland. Therefore, CréBeo provides a useful platform by which to assess the effects of environmental change on a range of taxa through soil monitoring. In turn, these data have been used to gain insights into relationships between the biodiversity of different groups of soil organisms under different land management strategies, and with vegetation and soil characteristics. The data is already contributing to policy at a European level, serving as a pilot area study in the EU FP6 ENVASSO project.

Key habitat structures shelter land snail assemblages against unfavourable environmental

Zita Kemencei (1), Péter Sólymos (1), Roland Farkas (2), Barna Páll-Gergely (3), Ferenc Vilisics (1), Erzsébet Hornung (1)*
(1) Department of Ecology, Faculty of Veterinary Science, Szent István University, Rottenbiller Str. 50, 1077 Budapest, Hungary
Aggtelek National Park Directorate, Jósvafő, Hungary
(3) Department of General and Applied Ecology, Faculty of Sciences, University of Pécs, Hungary

Land snails are known to perceive their environment on a fine scale. However, most malacological studies focus on local and regional patterns of snail assemblages and efforts have been exceptionally aimed to study at microhabitat level. We carried out our field study in 16 karstic depressions (all fully forested) with the extent of 0.5–2 acres. These negative geomorphologic forms enabled us to investigate the interacting effects of insolation (as aspect), moisture (as depth) and key habitat structures (live wood, dead wood, rock and litter microhabitat types), which are known to affect land snail abundance and occurrence. We applied five minutes time restricted search in a stratified sampling design using microhabitat types as strata, and three replicates per dolina per strata, resulting 192 samples. Based on the regression tree analysis, both species richness and abundance were highest in the rock and intermediate in the dead wood microhabitats, irrespectively to aspect and depth. For the litter and live wood microhabitat types, species richness was higher in northern and eastern aspects, and lower in southern and western aspects, abundance was higher in the doline bottoms than on the middle slopes. These findings indicate that key structural elements provide shelter and temper the effects of high temperatures and low moisture in forest landscapes. Thus habitat quality (naturalness), through the presence of keystone structures, can contribute to the adaptive capacity of soil dwelling invertebrates in a changing environment.

Are Collembola life-traits more reliable than taxonomical composition in assessing the effects of land-use intensification?

Pedro Martins da Silva (1), Matty P. Berg (2), Thomas Bolger (3), Maria Manuela da Gama (1), Tuomas Lukkari (4), Jean-François Ponge (5), Carlos Simón (6), Georgy Traser (7), Adam J. Vanbergen (8), Aoife Brennan (3), Florence Dubs (9), Eva Ivitis (10), Silvia Stofer (11), Allan D. Watt (8) & José Paulo Sousa (1)
(1) IMAR - Coimbra Interdisciplinary Centre, Department of Zoology, University of Coimbra, Largo Marquês de Pombal, 3004-517 Coimbra, Portugal
(2) Institute of Ecological Science, Faculty of Earth and Life Sciences, VU University Amsterdam, 1081 HV Amsterdam, The Netherlands
(3) Department of Zoology, University College Dublin, Dublin, Ireland
(4) Department of Biological and Environmental Science, University of Jyväskylä, Finland
(5) Museum National d'Histoire Naturelle, CNRS UMR 5176, 91800 Brunoy, France
(6) Universidad Autónoma de Madrid, Unidad de Zoología, 28049 Cantoblanco, Madrid, Spain
(7) Institute for Forest and Wood Protection, University of West, Sopron, Hungary
(8) Centre for Ecology & Hydrology, Hill of Brathens, Banchory AB31 4BW, UK
(9) Institut de Recherche pour le Développement, UMR 137 BioSol, 93143 Bondy, France
(10) FE LIS, Universität Freiburg, Tennenbacherstr. 4, D-79106 Freiburg, Deutschland
(11) Swiss Federal Research Institute WSL, CH-8903 Birmensdorf, Switzerland

Land-use intensification along with a gradient of forest fragmentation is known to negatively affect diversity of soil collembolan communities at the local level. This assumption was supported by the results of the former EU BIOASSESS project, where the effects derived from changes of landscape composition and structure along a land-use intensification gradient (within 8 European countries) were evaluated following a traditional "taxonomical" approach [e.g. 1, 2]. However, the biodiversity assessment based on this approach did not show a common pattern between countries along the forest fragmentation gradient [3]. Eco-morphological and life-history traits such as dispersal behaviour, habitat width, life forms and reproductive strategies could draw a more informative picture of diversity changes originated by the dynamics of the landscape [4, 5]. For instance, traits that allow species to survive in dynamic landscapes (fast-dispersal species), such as heterogeneous agro-forest mosaics, are likely to be different from those allowing species to persist locally, and may be related to the colonising ability of the species. On the other hand, slow-dispersal collembolans able to survive in highly disturbed monotonous agricultural landscapes (tolerant species), are expected to have a different trait composition in relation to the sensitive slow-dispersal species occurring in the homogenous forest landscapes. In this way the response of species diversity patterns to the forest fragmentation gradient could be more clearly explained by the underlying collembolan trait structure emerging in each landscape type. So far there are only few attempts to assess the impact of disturbance on collembolan communities using traits [e.g. 4, 5], probably due to a lack of data on several species. In this study, based on an extensive collembolan trait database, we revisited the BIOASSESS datasets and focused the analysis on the response of collembolan trait patterns to the forest fragmentation gradient at each one of the 8 studied European sites. The aim is to examine the extent to which life-history and eco-morphological traits are able to depict a common response pattern of collembolan communities among countries as an effect of the changes of landscape composition and structure. At each country we have analysed the total functional diversity (trait dissimilarity) on **Abstracts absolutely too long/cut**

The impact of hydrogeomorphological changes on planktonic diversity evolution in Musura Lagoon (Danube Delta)

Mirela Moldoveanu (1,2), Laura Parpala (1), Victor Zinevici (1), Doina Ionica (1), Larisa Florescu (1)*
(1) Institute of Biology, Romanian Academy
(2) University of Bucharest, Faculty of Biology, Department of Systems Ecology and Sustainability
*correspondent author- mirelamold@yahoo.com

Musura Lagoon, (45°10' 48.12"N latitude, 29°39'21.34"E longitude), belongs to avandelta, part of Danube Delta, Biosphere Reserve. The aim of this study was to compare the historical data recorded in Musura ecosystem with those more recent (2005 - 2007), in order to reveal the impact of hydrogeomorphological changes on structural and functional diversity evolution of the planktonic community. In the last 30 years, the ecological researches in lagoon revealed the relative fast dynamics at spatial - temporal scale. The resultant of the ecosystem evolution consists in a gradual transition from marine gulf stage to a half-closed lagoon, with many freshwater traits. The impact of factors as: the variation of water level (the decreasing of depth), the progressive decreasing of initial value of salinity (1942 - 12‰; 2005 - 0, 18‰) and the geomorphological changes, were favourable to proliferation of typical freshwater vegetation. The response of planktonic community is reflected at structural and functional diversity level (the species richness of phytoplankton and zooplankton and diversity of physiological groups of bacterioplankton). The structural diversity of phytoplanktonic assemblages recorded increased values in the period 1987 - 1989, but a low taxonomic constancy. It was reported the presence of 7 halophylic species, the rest of phytoplanktonic species was ubiquitous, with a wide range of salinity tolerance. During the last two years (2005 - 2007), the species richness reaches to a total number of 200 recorded species, belonging to 7 taxonomical groups, mainly ubiquitous and typical for freshwater ecosystems. In the period 1954 - 2005, 220 zooplanktonic species were recorded. The average of species richness during 1954 -1974 was 32 species and, currently, has increased up to 76 species in the last decades, according with the changes of the water chemistry. Taxonomically, there is a structural simplification due to the gradual disappearance of marine species. In this interval the rotifers are dominant. Only one marine zooplanktonic species, the meroplanktonic larvae of Balanus improvisus (Cirripedia), was revealed between 2005 - 2007. During the interval 1974 - 1975, the bacterioplankton community had not a characteristic seasonal dynamics, because the environmental factors from impact area between Danube water and marine water were instable. The functional diversity of bacterioplankton was defined by the dominance of the members of the organic matter with sulfur decomposers group. This fact is a peculiarity of the marine environment. Nowadays, the physiological groups of bacterioplankton became characteristic to freshwater ecosystem. From 2000 until present, the Musura Lagoon has an increased trend of isolation from marine water of Black Sea. This phenomenon is due to an active process of remodelation of the limit between the real Delta and marine waters and the alochtonous contribution of the Danube flow. These changes have led to the formation of an ecosystem with the specific features of an ordinary freshwater lake inside a maritime delta.

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About the ecological similarity of lampreys and salmonids

Marina V. Mosyagina (1), Andrey A. Shildyaev (1), Sako B. Tuniev (2)
(1) St-Petersburg State Univ., Dpt. of Ichthyology and Hydrobiology, V.O. 16th line 29, St. Petersburg, 199178, Russia; (2) Sochi National Park, Moskovskaya str. 21, Sochi, Krasnodarsky krai, Russia

Regardless of the fact that lampreys and salmonids belong to different classes of animals, similarity in their biology is surprising which was noted long ago (Berg, 1948, 1953; Gritsenko, 1968). Parasite lampreys, like salmons, spend the larval period in streams and only after metamorphosis to the juvenile stage undertake a downstream migration into the sea. Both lampreys and salmons have landlocked and anadromous migratory forms/populations, and migratory ones may enter the stream at a year of spawning or at a previous year (so-called *spring* and *winter* stocks). Interesting is a comparison between migratory lampreys and salmons of the genus *Oncorhynchus* since they both are monocyclic animals. However, studies of the early gametogenesis of lampreys are relatively few (Chubareva, 1957; Kuznetsov, 1971; Lubosch, 1903; Hardisty, 1961, 1964) as compared to those devoted to gametogenesis of Pacific salmons. On the other hand, a comparative study of a parasitic lamprey and a nonparasitic brook lamprey is very important as it may show an evolutionary pathway of derivation of nonparasitic forms from migratory parasitic ancestors. The main goal of this study was to determine age and size of beginning and completing of all phases of sex differentiation as well as to analyze the dynamics of the stock of gametal cells in two lamprey species, parasitic *Lampetra fluviatilis* L. from Black River (Saint-Petersburg, Baltic Sea basin) and nonparasitic *Lampetra* cf. *lanceolata* (Sochi, Western Transcaucasia, Black Sea basin). We have examined 74 specimens of the former (TL 26-124 mm) and 9 specimens of the latter (90-144 mm). It was found that sex differentiation in ammocoetes of *L. fluviatilis* starts early in ontogeny, namely at the end of the first year of life at a length of about 29 mm and completes by the end of the second year at a length of about 60 mm. All of 44 examined specimens of 30-60 mm TL had previtellogenous oocytes that clearly shows for the first time in literature that 100% of lamprey individuals undergo feminization during an early phase of their ontogeny. Thus, further gender inversion in genotypic males starts only after a generation of previtellogenous oocytes develops; that means that the lamprey is a juvenile protogynous hermaphrodite. These data corresponds to what was earlier revealed for hunchback salmon *Oncorhynchus gorbuscha* (Persov, 1975; Zelennikov, Fedorov, 2005). The comparative analysis of gametogenesis in ammocoetes of *L. fluviatilis* and *L.* cf. *lanceolata* shows that sex differentiation starts much later in the latter species, namely at 90-93 mm TL vs. 29-30 mm in the former. This difference may due to different taxonomic position of the species or different life strategy (parasitic migratory vs. nonparasitic brook). Besides, in the female lampreys examined, gonia and meiocytes do not present in the ovaries by the end of the second year of life which may be considered as the evidence of deep specialization towards semelparity, more pronounced than in all Pacific salmons which have previtellogenous oocytes simultaneously with mitotic proliferation of gonia and their proceeding to meiosis during the whole freshwater stage of life (during two to three years).

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Bryophyte vegetation of forests in relationship to forest management types

Jörg Müller (1), Steffen Boch (2), Dominik Hessenmöller (3), Daniel Prati (2), Ernst-Detlef Schulze (3)& Markus Fischer (2)
(1) University of Potsdam, Institute of Biodiversity & Systematic Botany; Maulbeerallee 1, 14469 Potsdam, Germany
(2) University of Bern, Institute of Plant Sciences; Altenbergrain 21 CH-3013 Bern, Switzerland
(3) MPI Biogeochemie Jena, Hans-Knoell-Strasse 10, 07745 Jena,Germany

Land use is one of the major determinants of biodiversity in the cultural landscape. Many studies deal with diversity of animals or higher plants but studies about bryophytes are underrepresented.

Within the Biodiversity Exploratories project we study bryophyte species diversity in relation to forest management types. We conduct the study in three landscapes in Germany: Schorfheide (Brandenburg), Hainich (Thuringia) and Schwaebische Alb (Baden-Wuerrtemberg) and observe moss and liverwort species growing on approximately one thousand $400m^2$ plots. For each bryophyte species we record also their underlying substrate. The investigated plots represent the whole forest type spectrum in each area, ranging from near natural beech forests to coniferous plantations.

Species number per plot and species diversity indices will be analysed in relation to forest management type, dominating tree species, standing biomass per plot, amount of dead wood and their decomposition state and several vegetation data. Moreover we will investigate correlations between bryophyte growing traits and forest conditions.

Changing the diversity of prokaryotic prey and protistan predators influence ecosystem functioning

Muhammad Saleem, Ingo Fetzer, Hauke Harms and Antonis Chatzinotas
Helmholtz Centre for Environmental Research – UFZ, Department of Environmental Microbiology
Permoserstrasse 15 04318 Leipzig/Germany

The trophic networks among bacteria, protists and viruses govern the biogeochemical cycling of nutrients in the ecosystem. Protistan predation on prokaryotes plays a major role in ecosystem functioning through the release of nutrients or the selective shaping of prokaryote community structure. Despite intensive work on the interactions among different prey and predator species, little is known about how different levels of prokaryotic diversity and thus microbial ecosystem services are affected by increasing predation pressure. Is there any change in biomass production and ecosystem functioning if prey and/or predator diversity were manipulated? Here we describe first results obtained from laboratory model systems. The experimental setup included microtiter plates which served as small volume microcosms. Species richness was manipulated by combining different prey (bacteria) and predator (protists) species; biomass production as well as metabolic activity served as parameters to answer the above stated questions.

Diversity and abundance patterns of ground-beetles in the Madeiran Laurisilva: the contribution of environmental and spatial variables

Artur R.M. Serrano (1), Mário Boieiro (1), Carlos A.S. Aguiar (1), Eduardo Brito de Azevedo (2), Carla Rego (1), Isabel A. Rosário (1), Sérvio P. Ribeiro (3), Fernando Pereira (4,5) & Paulo A.V. Borges (5)
(1) Centro de Biologia Ambiental/Departamento de Biologia Animal, Faculdade de Ciências da Universidade de Lisboa, R. Ernesto de Vasconcelos, C2, 1749-016 Lisboa, Portugal
(2) Universidade dos Açores, Dep. de Ciências Agrárias – CMMG (Centro de Estudos do Clima, Meteorologia e Mudanças Globais), Terra-Chã, 9700-851 Angra do Heroísmo, Terceira, Açores, Portugal
(3) Universidade Federal de Ouro Preto, Instituto de Ciências Exatas e Biológicas, Lab. Ecologia Evolutiva de Herbívoros de Dossel/DECBI, Campus Morro do Cruzeiro, 35400–000, Ouro Preto, MG, Brasil
(4) GESPEA Grupo de Estudo do Património Espeleológico dos Açores. Edifício Matos Souto, Piedade, 9930 Lajes doPico, Pico, Açores, Portugal
(5) Universidade dos Açores, Dep. Ciências Agrárias, CITA-A (Azorean Biodiversity Group), Terra–Chã, 9700–851 Angra do Heroísmo, Terceira, Açores, Portugal

Field work was conducted within the Laurisilva of the Madeira Island. Twenty eight sites were chosen throughout the island. Each site was sampled using a transect of 30 pitfall traps, the traps were set 5 meters apart and filled alternatively with ethylene glycol or turquin. The sampling protocol was standardized for a period of fifteen days, which started between 22 and 26 May and finished between 5 and 9 June 2006. So, each trap was operational during an identical period. Environmental data was obtained from a climatic model and GIS. The surrogate value of environmental and spatial variables on a small-scale gradient of ground-beetle species richness was examined with SAM (Spatial Analysis in Macroecology). The abundance-occupancy and abundance-variance relationships were investigated using SADs (Species Abundance Distributions).

The aims of this work were: 1) to examine how a variety of environmental (climatic) and spatial factors (latitude and longitude) influence epigean ground-beetle species richness on an oceanic island; and 2) to evaluate patterns of rarity of selected endemic species (*Orthomus berrai*, *Orthomus curtus* and *Orthomus susanae*), contributing to the understanding of their abundance structure.

Abiotic (climatic) variables explain the variation in species richness, whereas the space has no explanatory value. However, the spatial variables explain almost all the variation on the abundance of the selected endemic species. The unified abundance-variance-occupancy model fits extremely well to data.

Rainfall and temperature are good surrogates of ground-beetle species richness, with the hotspot areas being located in hyper-humid and colder Laurisilva. Some endemic species show an interesting complex abundance structure with high abundance patches and low abundance gaps in a complex geomorphologic island.

Plant species diversity on grasslands on its best

Stephanie Socher (1), Steffen Boch (1), Henryk Baumbach (2), Jörg Müller (2), Dani Prati (1) & Markus Fischer (1,2)
(1) University of Bern, Institute of Plant Sciences, Altenbergrain 21, 3013 Bern, Switzerland
(2) University of Potsdam, Institute Biology and Biochemistry, Maulbeerallee 1, 14469 Potsdam, Germany

Land-use and changes in land-use intensity are one of the most important drivers of plant diversity, particularly in the cultural landscape of Central Europe. This relationship is investigated as part of the Biodiversity Exploratories which were recently established in Germany as a platform for biodiversity research (http://www.biodiversity-exploratories.de/). The focus of the program is on land-use mediated changes in biodiversity and the evaluation of land-use effects on ecosystem processes. Our research team focuses on plant diversity and aims to understand how the type and intensity of land use affect species richness and functional diversity, how regional species pool and disturbance affect the diversity and productivity of plant taxa, and how land use affects population biology and population genetics of selected taxa.

There are three exploratory regions in North, Central and South Germany. We recorded vegetation in 500 grassland plots of $16m^2$ in each of these regions on different land use regimes. The land use regimes ranged from low intensity use (i.e. not fertilized with a mean of 24 species per plot) to highly intensive land-use (i.e. fertilized with a mean of 16 species per plot). In each exploratory 50 out of 500 plots were chosen as representatives for the land use type. Criteria for plot selection were the soil types and the current land use. The designed gradient for land use regimes varies from low intensive sheep pastures up to three times per year mown meadows. Vegetation relevés will be taken in 2008 and 2009 to be able to analyze temporal changes in species composition and diversity.

Our poster presents results from the first season on how species diversity and composition differ according to type and intensity of land use and site conditions.

We assessed the relative importance of land use, soil types, and site- and region-specific characteristics on the number, composition, and abundance of plant species and plant functional groups. In conclusion, our data will highlight the importance of large-scale, multi-site analyses of vegetation data to identify important drivers of biodiversity.

Functional barcodes for assessing active fungi in biodiversity studies

Solé M (1), Meusnier I (2), Hajihababei M (2), Harms H (1) and Chatzinotas A (1)
(1) Helmholtz Centre for Environmental Research — UFZ, Department of Environmental Microbiology, Permoserstrasse 15, 04318 Leipzig, Germany
(2) Canadian Centre for DNA Barcoding, Biodiversity Institute of Ontario, University of Guelph, Guelph, Ontario, N1G 2W1, Canada

DNA barcoding is a molecular approach used to identify specimens and to assess biodiversity through the use of orthologous small DNA sequences, the "DNA barcodes". The value of DNA barcodes to detect hidden variability has been now widely recognized for several large groups of animals like birds, fish, cowries, spiders, and several Lepidoptera.

While DNA barcoding, via the routine sequencing of the SSU RNA gene, is a common tool to study complex microbial communities in soil, sediment or aquatic environments, this approach is still not adequately taken into account for other microbial groups like algae, fungi and protists.

Candidate genes suited for DNA barcoding are usually selected according to their taxonomical value, i.e. the capability of the genetic marker to discriminate between specimens. However, for environmental studies the identification of functionally active members in a community is of most importance to distinguish between the microbial "seed bank" (potential diversity) and the established active populations (realized diversity), since they will potentially differ as a response to biotic and abiotic factors. Therefore for biodiversity studies in an ecosystem context, we propose to consider additionally to the taxonomic value usually provided by the genetic marker, a functional value for the choice of appropriate DNA barcodes.

Our study aims at comparing the taxonomic value of four molecular markers (LSU, SSU, ITS and COI) for the identification of aquatic hyphomycetes, an important key group dominating the litter decomposition in freshwater environments. Exemplary, we will demonstrate the functional value of these barcodes in the fungus *Heliscus lugdunensis*, by comparing the level of expression of the DNA barcodes in active (mycelia) and dormant (spores) states of the aquatic fungus.

Grassland plant community adaptation at a regional scale: a project presentation

Karoline Weißhuhn (1), Harald Auge (1), Markus Fischer (2) & Daniel Prati (2)
(1) Helmholtz Centre for Environmental Research; Theodor-Lieser Str. 4, 06120 Halle, Germany
(2) University of Bern, Switzerland

Biodiversity is a widely used term, but mostly applied to the diversity of species. However, biodiversity within species is important for adaptation and evolutionary processes which can generate well-adapted populations in different ecosystems. Transplantation experiments showed that plants grow and reproduce better in their home sites than at foreign sites. In these experiments, plants of single species were transplanted into foreign plant communities, where they were confronted with different environmental conditions, including pathogens and herbivores. Due to local adaptation the Convention on Biological Diversity calls for the protection of local provenances of single species. However, plant species for agricultural or ornamental use are ever changing by breeding and some cultivars spread widely in the former wild range of the species, e.g. grasses and legumes sown in pastures. These processes may genetically swamp locally adapted populations and thereby reduce fitness of local populations. While such processes have been studied with single-species case studies, little is known how transplantation of whole communities affects ecosystem functioning. Here, we present a project where we are studying how seeds of plant communities of different provenance establish outside their local sites compared with their establishment at the local site. We sowed seeds of 15 species of grassland communities from 5 provenances to two sites in Central-Germany and Switzerland. We want to test a) how provenances differ in seedling establishment, b) how the whole community develops regarding primary productivity and community stability and c) how herbivores and plant pathogens influence foreign and native provenances. We hypothesise, that seeds of an adapted community will establish better and show higher productivity and stability than seeds of foreign communities. Moreover, foreign plants may be preferred by herbivores or more susceptible to pathogens because these plants are not adapted against local antagonists. In conclusion, community transplantation experiments of the kind presented in this project may highlight the importance of local seed material and bear important implications for restoration ecology and the stability of ecosystems.

Effects of land use on pollinator assemblages: a comparison of intensively and extensively used meadows

M. Werner, C.N. Weiner, K.E. Linsenmair, N. Blüthgen,
University of Würzburg, Department of Animal Ecology and Tropical Biology, Biozentrum Am Hubland, 97074 Würzburg, Germany, M.Werner@biozentrum.uni-wuerzburg.de

Pollinators are essential for a large number of wild plants as well as for economically important crops. The intensity of grassland management may influence the pollination service. We investigated flower visiting insects on differently managed grasslands. The study is part of the DFG-funded Biodiversity Exploratories project. We focus on resource-based mechanisms that may determine communities of all flower visiting insects including pollinators.

From May to August 2007 we sampled 20 extensively and 20 intensively used meadows from a pre-selection of plots in the Swabian Mountains. Both types of meadows were sampled simultaneously (pair-wise design). Ten such pairs were sampled before the first mowing and ten pairs 1-2 months afterwards. All momentarily flowering plant species, an estimate of the total number of flower units per species, and all flower visitor-plant interactions during six hours were recorded on 1000 m² per site. A 'flower unit' was defined as a compact aggregation of flowers in which insects are able to reach all flowers without flying. The size of one flower unit was quantified for each species.

The total number of interactions was significantly higher on extensively used meadows before mowing. After mowing, no significant difference between the two types of meadows was found. The abundance of important pollinator taxa (hoverflies, honeybees, bumblebees and solitary bees) was highly variable in space and time, but only two consistent differences between both types of meadows were found: Firstly, hoverflies accounted for a significantly higher proportion of interactions in intensively used meadows. Secondly, *Apis mellifera* and solitary bees were responsible for a significantly higher proportion of interactions after mowing. Overall, the visitation rate of a plant species significantly increased with its flower size. However, we found a decreasing visitation rate per flower unit with an increasing total area of flower units per plot.

Butterfly and grasshopper diversity and its predictors on mountainous habitats of Greece

Konstantina Zografou (1), Spyros Sfenthourakis (2) & Vassiliki Kati (1)*
(1) Department of Environmental and NaturalResources Management, University of Ioannina, Seferi 2, 30100 Agrinio, Greece
(2) University of Patras, Department of Biology, Section of Animal Biology, University Campus, 26504 Patra, Greece
** corresponding author*

Insects, in general, respond more rapidly to disturbance than vertebrates, therefore can be used as early indicators of environmental change. Moreover, several invertebrate groups have been evaluated as possible surrogates of overall biodiversity, with butterflies having a promising role as bioindicators of both ecosystem quality and biodiversity.

This study aimed at examining the diversity patterns and the ecological structure of the butterfly (Papilionoidea) and the grasshopper (Orthoptera) communities at Mt. Grammos (northern Greece), and to evaluate covariance of their diversity patterns. A network of 22 sites was selected so as to efficiently represent the most common habitat types of the area. Nineteen environmental variables were recorded in each site.

Three consecutive sampling periods were used for butterflies, from late spring (May) to summer (July). A total of 120 butterfly species were found, including two species (*Parnassius apollo*, *Euphydryas aurinia*) that can identify the region as a Prime Butterfly Area, while 27 more known to be Species of European Conservation Concern (SPEC). Sampling for Orthoptera took place during the summer (July – August). A total of 60 species were recorded. The most important species from a conservation point of view was *Pholidoptera fallax*, a species previously known in Greece only from the area of eastern Thraki (northeastern Greece).

The sites hosting highest diversity were the semi-natural old pastures for butterflies, and forest openings and grasslands for Orthoptera, whereas subalpine grasslands supported most species of SPEC status. We classified the 22 sites according to flowering (nectar-producing plants) and to heterogeneity using an ordination procedure (DistPCoA) for butterflies, while the sites were further separated in two main categories (forests and old pastures) for Orthoptera.

In order to assess the main environmental factors that determine butterfly and Orthoptera diversity, we employed a Redundancy Analysis (RDA, in CANOCO). The main environmental factors for butterflies were the presence of flowers and trees (<10m) and elevation, whereas for Orthoptera, the small shrubs (<0.5m), bare ground, the river area, the presence of flowers and elevation. There was a significant, positive relationship between butterfly and Orthoptera species and presence of flowers, and a negative relationship between butterfly and Orthoptera species and elevation. Furthermore, species richness of Orthoptera and butterflies were significantly intercorrelated (Spearman rank-order correlation coefficient), indicating a possible role of these groups as bioindicators in biodiversity assessment and conservation efforts.

Identification and sustainable use of ecosystem services

4.6. Change in agricultural landscapes in Central Europe: Implications for ecosystem functioning

Stefan Hotes, Wolfgang Weisser

Oral presentations

Managing biodiversity and ecosystem services in changing landscapes

Tscharntke, Teja
Georg-August-University, Agroecology, Waldweg 26, 37073 Göttingen, Germany

Understanding biodiversity and ecosystem services requires a landscape perspective, because most species experience their habitat at spatial scales beyond the plot level, and there is spillover of natural enemies across habitats. In human-dominated landscapes this means dispersal between managed systems and natural habitat. Conservation and land-use management are often focused on few species and local processes, but in dynamic landscapes, only a diversity of insurance species may guarantee resilience (the capacity to reorganize after disturbance). Traditional views include species-area relationships in fragmented landscapes, including a trophic-level hypothesis of habitat fragmentation, because specialist, but not generalist, natural enemies are more affected by habitat fragmentation than their prey or host. The SLOSS debate (Single Large or Several Small habitats) and the increasing consideration of beta diversity make clear that (i) the landscape-wide turnover of communities is the main driver of biodiversity and (ii) a just local habitat perspective may lead to wrong conclusion about the habitat type's biodiversity value. Structurally complex landscapes enhance local diversity in agroecosystems, which may compensate for local high-intensity management (the compensation by landscape complexity hypothesis). Organisms with high dispersal abilities appear to drive these biodiversity patterns and ecosystem services, because of their recolonisation ability and larger resources experienced. Agri-environment schemes (incentives for farmers to benefit the environment) need to broaden their perspective and to take the different responses to management in simple (high-impact) versus complex (low-impact) agricultural landscapes into account. In simple (but not totally cleared) landscapes, local allocation of habitat is more important than in complex landscapes (the intermediate landscape complexity hypothesis). In addition to landscape composition (or landscape complexity), landscape configuration facilitating dispersal (via corridors) or inhibiting dispersal can be important. In many cases, diversity of functional groups is related to ecosystem functioning and services such as biological control and pollination. Complementary resource use may lead to a positive relationship between diversity and these processes, but only when a diverse array of niches is available to be partitioned among species. Last not least, trophic interactions are only part of complex food webs, which may be best illustrated in quantified interaction webs. In conclusion, complex landscapes characterized by highly connected crop-noncrop mosaics may be best for long-term conservation of high biodiversity sustaining ecosystem services, but experimental evidence for detailed recommendations to design the composition and configuration of agricultural landscapes is still needed.

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Influence of within-field position, adjoining habitat and landscape composition on carabid beetles in winter wheat

M. Zubair Anjum (1), Martin H. Schmidt (2) & Thomas Frank (1)
(1) Institute of Zoology, Dept of Integrative Biology and Biodiversity Research, University of Natural Resources and Applied Life Sciences Vienna, Gregor Mendel Strasse 33, AT-1180 Vienna, Austria
(2) University of Bern, Zoological Institute, Baltzerstrasse 6, CH-3012 Bern, Switzerland

The influence of within-field position, adjoining habitat and landscape composition on carabid beetles was studied in 20 winter wheat fields in ten different Swiss agricultural landscapes. In each landscape, two winter wheat fields (one with adjoining sown wildflower area and one with adjoining grassy margin) were investigated. Carabid beetles were caught in pitfall traps 3 m and 30 m from the edge in each of the twenty wheat fields. Overall, 10885 individuals of 51 different carabid species were caught. The average number of carabids captured differed between field edges and centres. Significantly more individuals were found in the centres (30 m position) than at the edges (3 m position) but species richness was significantly higher at the edges than in the centres. Density of the ten most abundant species which occurred in at least 20 of the 40 sampling positions was analyzed with linear mixed-effect model with nested random effects. *Poecilus cupreus*, *Agonum muelleri* and *Pterostichus melanarius* were significantly more abundant in the centres than at the edges. *Harpalus rufipes* was significantly more abundant in the fields adjoining sown wildflower areas than in the fields adjoining grassy strips. Individual numbers of *Bembidion properans* at the field edges were significantly positively correlated with the amount of perennial habitat. The other five among the most abundant carabid species (*Anchomenus dorsalis, Pterostichus vernalis, Asaphidion flavipes, Clivina fossor, Anisodactylus binotatus*) showed no significant relation to within-field position or adjoining habitat. Overall, we concluded that the relation of studied carabid beetles to within-field position and adjoining habitat is species specific which has to be taken into account when management measures are planned that aim at supporting potential natural enemies of cereal pests.

Nature conservation and flood prevention in agricultural landscapes - are synergetic effects possible?

Hermann Heilmeier (1), Elke Richert (1), S ylvi Bianchin (1), Gert Hammer (2), Mariusz Merta (3) & Christina Seidler (3)
(1) TU Bergakademie Freiberg, Interdisziplinäres Ökologisches Zentrum, Leipziger Str. 29, 09599 Freiberg, Germany
(2) Büro für Hydrologie und Bodenkunde, Beethovenstr. 3, 01465 Dresden/Langebrück, Germany
(3) Internationales Hochschulinstitut Zittau, Umwelt-Biotechnologie, Markt 23, 02763 Zittau, Germany

The Weisseritz catchment (Eastern Erzgebirge, Saxony, Germany) was heavily affected by the floods in August 2002. Effective flood prevention, apart from hydrological engineering, calls for major changes in land use especially in flood generation areas. What is the effect of land use changes on flood prevention, and are there synergistic effects with nature conservation and biodiversity at the landscape scale? These questions were at the focus of the project "Flood Prevention and Nature Conservation in the Weisseritz area" ("HochNatur"). For two sub-catchments different land use scenarios were developed and evaluated considering guidelines from both nature conservation and flood prevention perspective. From the nature conservation point of view major aims of the measures were maintenance and development of endangered species and habitat types and improvement of habitat connections and landscape connectivity. Increase of water retention in the whole catchment, i.e. a higher water storage capacity of the soil and a reduced flow velocity of surface and subsurface flow and in running waters, were major goals from the flood prevention perspective.

For planning the intended land use changes a detailed survey of the present state with respect to landscape ecology and hydrology via systems analysis and modelling was done to analyse and evaluate the landscape structure and to identify prioritized measure areas with fast runoff components and with deficits from the view of nature conservation. For areas with fast run off components measures were conceived which improve the rooting intensity and thus the water infiltration and storage capacity of the soils. This can be done through the establishment of habitat specific indigenous woody plants and permanent grasslands with high species richness. These measures additionally increase surface roughness and thus reduce soil erosion. Depending on the present situation and the extent of the measures, land use changes which integrate nature conservation goals can reduce peak flow in running waters up to 25%. The evaluation of these scenarios with landscape structure indices (Shannon diversity, interdispersion/ juxtaposition) show, compared to the present state, a high increase of landscape diversity and spatial heterogeneity for which land use changes on 50-85% of the total area were effected. Renaturation measures in a small river, among them removal of hydraulic constructions, meandering of the river course, establishing riparian buffers and utilisation of former fish ponds as water retention basins, can reduce peak flow in the river up to 30% by increased water retention and delayed runoff.

The results demonstrate the potential for integration of various ecosystem services for changing land use patterns and show that measures aimed at nature conservation (landscape, habitat and species diversity), landscape conservation and aesthetics (recreation potential) synergistically interact with flood prevention and soil protection.

Poster presentations

How do local and landscape scale effects influence the spider assemblages in Hungarian pastures?

Péter Batáry (1,2), András Báldi (3), Ferenc Samu (4), Tamás Szűts (5,6), & Sarolta Erdős (1,7)
(1) Hungarian Natural History Museum, Department of Zoology; Ludovika tér 2, 1083 Budapest, Hungary
(2) Georg-August University, Agroecology; Waldweg 26, 37073 Göttingen, Germany
(3) Animal Ecology Research Group of the Hungarian Academy of Sciences and the Hungarian Natural History Museum; Ludovika tér 2, 1083 Budapest, Hungary
(4) Department of Zoology, Plant Protection Institute of the Hungarian Academy of Sciences; Pf. 102, 1525 Budapest, Hungary
(5) Systematic Zoology Research Group of the Hungarian Academy of Sciences and the Hungarian Natural History Museum, Baross u. 13, H-1088 Budapest, Hungary
(6) Department of Entomology, Zoological Museum and University of Copenhagen; Universitetsparken 15, 2100 Copenhagen, Denmark
(7) Szent István University, PhD School of Environmental Sciences; Páter K. u. 1., H-2100 Gödöllő, Hungary

Declines of West European farmland biodiversity have been associated with intensive agricultural practices, while in Central and Eastern European countries grasslands still harbour a diverse and unique arthropod community. However, our understanding of the effects of farmland management both at local and landscape levels is rather limited there.

A paired field approach was used to compare extensively (0.5 cows/ha) and intensively (>1 cows/ha) grazed pastures in 42 fields in three Hungarian biogeographic regions. Spiders belonging to the hunting and web-building communities were sampled using funnel traps. We recorded 60 hunting species with 5045 individuals and 32 web-building species with 612 individuals.

Grazing intensity had no measurable effect either on spider abundance or diversity. At community level the direct gradient analysis also showed no management effect at all. At the local scale plant and litter cover were the two most important variables that significantly affected the communities overall, meaning both the hunting and to some degree the web-building communities. No significant landscape effects were found in the analyses on spider richness and abundance, but community structure was affected by two landscape level factors (grassland patch density and grassland percentage).

We found no management effect either on richness and abundance or on species composition, which shows that both forms of grazing management at the intensity levels studied support valuable spider fauna. Finally we have to emphasise that variables of different scales should be analysed together, because not only local but also landscape variables affect spider fauna in these systems.

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Predators of insect pests in oilseed rape specifically affected by landscape factors

Thomas Drapela, Johann G. Zaller, Dietmar Moser & Thomas Frank
University of Natural Resources and Applied Life Sciences Vienna, Institute of Zoology, Gregor Mendel-Str. 33, 1180 Vienna, Austria

The importance of oilseed rape (*Brassica napus*) as a source of industrial and nutritional oil has been increasing worldwide during the last 20 years and will probably increase further due to the current boost in energy crop and biofuel production. This has led to a rising demand in cropping area and has increased the pressure on set-aside land and other non-crop areas dramatically; areas that are known to be of great importance for beneficial arthropods (e.g., predators, parasitoids, pollinators) in arable fields. Given this development, the role of non-crop areas for maintaining agroecosystem functions such as pollination or natural pest control, has become of growing interest in ecological research. Assemblages of epigeic arthropod predators, mainly spiders (Araneae), ground beetles (Carabidae) and rove beetles (Staphylinidae), were shown to be able to reduce the emergence of insect pests from oilseed rape fields but little is known about their relation to the surrounding landscape.

We studied the influence of landscape factors (e.g., percentage of non-crop area and fallows, landscape diversity) on activity density and fitness related traits (body size, fecundity) of the dominant spider, ground beetle and rove beetle species in 29 winter oilseed rape fields in Eastern Austria using pitfall traps. Landscape data were obtained from circular landscape sections around each study field (r = 250-2000 m). Data were analysed using regression models.

Preliminary results show that the studied predator species clearly differed in their response to landscape factors. The wolf spider *Pardosa agrestis* benefitted from non-crop areas in the surrounding landscape, while the ground beetle *Poecilus cupreus* and the rove beetle *Tachyporus hypnorum* remained largely unaffected. *Pardosa agrestis* also showed a strong positive relation to road-side strips in the surrounding landscape indicating that relatively small but connective habitats may become especially important in intensively managed agricultural landscapes.

Overall, our data indicate that non-crop habitats should be interspersed within the matrix of arable fields in a way that distances between non-crop and crop areas are kept short and that non-crop elements in the agricultural landscape can specifically influence different species of epigeic arthropod predators. Such species specificity in predator-landscape relations can have important implications in the context of natural pest control. Despite diverging relations for different species, our results underline the need to conserve non-crop areas in agricultural landscapes given their general importance for predatory arthropods.

Impact of de-embankment on vegetation restoration and biodiversity in a coastal brackish grassland system

Jasmin Lendzion, Stefan Seiberling & Stefan Zerbe
University of Greifswald, Institute of Botany and Landscape Ecology, Grimmer Str. 88, 17487 Greifswald, Germany

Coastal brackish grasslands of the Baltic Sea are the result of age-long livestock grazing and are important habitats for many plant and animal species. Due to embankment, infrastructure development and abandonment of livestock grazing, coastal brackish grassland continue to degrade. The restoration of degraded habitats and the development of management schemes for the conservation of this unique ecosystem are therefore an important task. We report on a restoration project on a 350 ha area near Greifswald at the coast of the Greifswalder Bodden, a shallow lagoon in the Baltic Sea, Germany. Intensive diking stopped flooding in the area in 1910. In 1993 the natural flooding was re-introduced after de-embankment.

On three transects and permanent plots, we recorded biodiversity changes, restoration of vegetation and productivity of the area since 1994 until now. The results of our study show that five years after de-embankment and with traditional livestock grazing, nearly all typical species and most of the vegetation was re-established. Ten years after re-introducing of flooding, productivity of the sites reached values as before de-embankment. However, restoration of the complexity and biodiversity of the whole ecosystem needed more than 13 years. The impact of de-embankment on re-establishment of the vegetation was mainly dependent on the elevation of the sites above sea water level and was facilitated by grazing and drainage. Our study results show that the restoration of brackish grasslands is possible, but depends on site selection, implementation and management. Basically, the potential for a successful restoration is higher compared to saltmarshes of tidal coasts.

Effects of management abandonment on floristic diversity and Si-storage in a riparian wetland

Wout Opdekamp (1), Eric Struyf (1,2), Hans Backx (1) & Patrick Meire (1)
(1) University of Antwerp, Department of Biology, Ecosystem Management Research Group; Universiteitsplein 1C, 2610 Wilrijk, Belgium
(2) Lund University, Department of Geology, GeoBioSphere Research Centre; Sölvegatan 12, SE-223 62 Lund, Sweden

Traditional management of many peatlands in Central-Europe consisted of yearly harvesting of the aboveground biomass, which led to nutrient removal and a decrease in light competition. This resulted in the development of species-rich fen meadows.

During the last decades however many of these meadows have been abandoned due to the limited economical benefit, a process that also took place in the Biebrza river valley in Eastern Poland.

In the upper course of the Biebrza valley several parcels were selected, differing in management type [yearly mown (MO) vs unmown since 20 years (UN)] (Fig 1).

Here, mown meadows are more divers compared with abandoned ones (# species/point, MO vs UN: 17.7 ± 4.4 vs 11.6 ±3.3). In the abandoned sites, the development of large tussocks by several Carex species causes light competition. This competition limits the distribution of low growing or late flowering species [1].

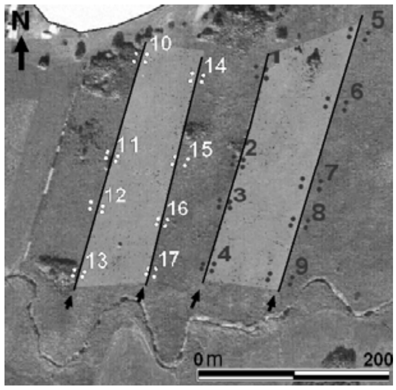


Figure 4: Location of sampling points. Light-grey parcels are yearly mown, adjacent parcels are abandoned (20 years).

Riparian wetlands such as these play a role in nitrogen (N) and phosphorus (P) cycling [2], but less is known about their role in Si-cycling, although this element has an impact on the occurence of algal blooms downstream [3].

To test whether silica storage and recycling depends on management type and vegetation composition [4] soil cores have been taken to determine Amorphous Silica (ASi) concentrations.

ASi concentrations differed not only between MO and UN (0.27±0.03 wgt% and 0.37±0.05 wgt%), but when corrected for the variation explained by the distance to the river a positive relation with the coverage by Poaceae+Cyperaceae is found (Fig 2.)

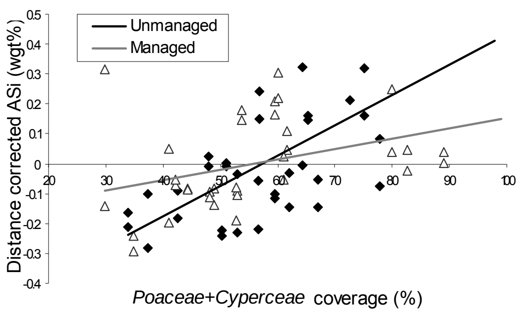


Figure 2: Effect of grass & sedge coverage on Distance Corrected ASi concentration

This means that cessation of management not only affects floristic diversity at the site itself, but might also influence the ecosystem functioning downstream through changes in Si-cycling.

[1] J Veg Sci (2004) 15: 583-594
[2] Appl Veg Sci (2006) 9: 163-174
[3] Limnol Oceanogr (1997) 42:1137-1153
[4] Front Ecol Environ 2008; 6, doi:10.1890/070126

Assessment of landscape heterogeneity changes according to the system of landscape indicators

Dušan Romportl (1), Tomáš Chuman (1) & Kateřina Jačková (1), Eva Semančíková (2), Veronika Holcová (2)
(1) Charles University, Faculty of Science, Department of Physical Geography and Geoecology, Albertov 6, 12843 Prague 2, Czech Repubulic
(2) University of South Bohemia, Faculty of Science, Department of Ecosystem Biology, Branišovská 31, 370 05 České Budějovice, Czech Republic

Land use change in the Czech Republic follows European and international trends. Many regional cultural landscapes have disappeared because of deep changes in society; many others are being endangered by the processes of urban sprawl, afforestation, extensification or on the contrary of intensification of agriculture and generally globalization and unification. Locally, conservation or even restoration of the traditional landscapes is being considered for the reasons such as tourism, tradition, ecological stabilization, scenic value or landscape character protection. The consequences of these types of landscape transformation are changes of functional pattern, material and energy flows and change of biodiversity.

The assessment of landscape diversity and heterogeneity changes belongs to the traditional topics of landscape-ecological studies. However, most outputs of these rather scientific, specialised or just local studies are not generally applicable for the whole territory to assess negative impacts of land change processes by politicians and other decision makers. Therefore synthetic, complex and high aggregated but as exact as possible overview is required by institutions dealing with the nature and landscape protection. Our proposed system of landscape indicators offers a simple but well utilizable useful tool for landscape heterogeneity assessment. A set of indicators was used for a classification of land cover changes, and additionally for structural changes and its functions during last fifteen years.

Initially the basic single parameters describing landscape structure were processed in a 1x1 km grid using the databases CORINE Land Cover 1990 and 2000. After that landscape diversity, heterogeneity, coherence and fragmentation parameters were analysed using the following landscape indicators:

- landscape heterogeneity and diversity - *Richness, Shannon´s Diversity Index, Shannon´s Evenness Index, Dominance and Proportion*
- landscape openness and closeness – *SIMI, ENN Indicators*
- connectivity of land cover classes – *Patch Cohesion Index, Traversability Index*

As Czech landscapes are represented as a heterogeneous area, landscape diversity and heterogeneity changes between 1990 and 2000 differentiate spatially according to the distribution of landscape types of the Czech Republic. The next step of this project is an interpretation of landscape diversity/heterogeneity changes, a biodiversity and land - use changes relationship.

Changes in submountain agricultural landscape and their consequences on biotopes of non-forest woody vegetation

Zuzana Válkovcová
Institute of Landscape Ecology, Stefanikova 3, 814 99 Bratislava, Slovakia

During the last 50 years the agricultural landscape in Slovakia has undergone significant alterations resulting from political and socio-economic changes. The period from 1950s till 1980s in the last century was characteristic by intensification of agricultural production, integration of small fields of arable land and large scale reclamations. All of these measures have led to reduction of small biotopes, e. g. biotopes of non-forest woody vegetation, and significant decreasing of diversity of landscape structure. The opposite trend, which is abandonment of agricultural land arose after 1989, and was related with transition from a socialist, planned economy towards the market economy. Nowadays these two opposite processes, the intensive agriculture and increasing pressure on landscape in the form of construction in the vicinity of the villages and towns on one side, and the continuing abandonment occurring in more distant and hardly accessible areas with the processes of succession and slow comeback of forest communities on the other side take place in submountain, agriculturally utilised landscape simultaneously.

A good example to illustrate these processes is non-forest-woody vegetation, characteristic by high stabilising effect on agricultural landscape, but it is also among the first biotopes, which are a subject of change. The paper is focused on evaluation of land use changes in three time horizons (1957, 1986, and 2007), and their consequences on biotopes of non-forest woody vegetation in submountain agricultural landscape.

Impacts of energy maize production on phytodiversity: modelling results for two marginal and intensively managed landscapes in Germany

Rainer Waldhardt, Dietmar Simmering, Oliver Ginzler, Annette Otte
Justus-Liebig-University Giessen, Landscape Ecology and Landscape Planning, Heinrich-Buff-Ring 26-32, 35392 Giessen, Germany

In the recent past, European agricultural landscapes – as well as many other landscapes worldwide – have been affected by politics to enhance the use of renewable energy sources. With this aim in mind, various strategies and production systems, including energy maize production, have been developed and implemented. According to [1], about 0.24 million ha were cultivated with maize as a feedstock for biogas production in Germany in 2007 and this acreage is expected to increase in the near future. From numerous vegetation studies, negative effects of maize production on the phytodiversity of arable fields (patch scale) are well known. However, effects of increasing maize production on landscape scale phytodiversity have not been quantified to date.

Given the examples of two agricultural landscapes in Hesse (Germany) - the Lahn-Dill-Highlands, a marginal landscape, and the Wetterau, a regional breadbasket -, we calculated potential effects of increasing energy maize production on landscape phytodiversity. Calculations are based on species-specific frequencies derived from patch-specific field data. The modelling approach ProF was used for the up-scaling of patch data to the landscape scale, [cf. 3, 2]. Further, we consider the amount of phytomass required annually by a small biogas refinery (producing about 2.5 million m^3 methane per year), the regional crop rotations and also economic and logistic factors determining the distance between refineries and maize fields. Our results indicate that plant species richness may significantly decrease and also species composition may be negatively affected in the surrounding of biogas refineries, with more pronounced effects in the considered marginal landscape. Hence, today's energy maize production may not meet ecological demands of multifunctional land-use systems.

[1] DMK – Deutsches Maiskomitee (2008). Anbau von Mais zur Energienutzung in Deutschland nach Bundesländern 2006-2007. Internet publication on www.maiskomitee.de.
[2] Sheridan P, Waldhardt R (2006). Spatially explicit approaches in integrated land use and phytodiversity modelling at multiple scales. In: Meyer BC (ed). Sustainable Land Use in Intensively Used Agricultural Regions. Alterra Report No. 1338, Wageningen: 68-72.
[3] Waldhardt R, Simmering D, Otte A (2004). Estimation and prediction of plant species richness in a mosaic landscape. Landscape Ecology 19: 211-226.

Impact of different land use intensity on chemical odour diversity, structural complexity of vegetation and host-parasitoid interactions

Nicole Wäschke (1), Christine Herbst (2), Elisabeth Obermaier (2), Torsten Meiners (1)
(1) Institut für Biologie, AG Angewandte Zoologie / Ökologie der Tiere, Haderslebener Str. 9, 12163 Berlin, Germany
(2) Lehrstuhl für Zoologie III, Tierökologie und Tropenbiologie, Am Hubland, 97074 Würzburg, Germany

The recent worldwide anthropogenic conversion of natural habitats to agriculture profoundly affects the diversity of plants and animals. It is well documented that increasing land use intensity and fragmentation lead to a serious reduction in plant and animal species diversity. However, how these changes affect biotic interactions apart from reducing species numbers also in a functional way is hardly known yet.

The composition and chemical diversity of the volatile bouquet of the vegetation within a habitat changes with plant diversity. Since insects use odour for successful location of resources, volatile chemical diversity within a habitat might strongly interfere with biotic interactions. Likewise, complex vegetation structure might impede natural enemies from finding their prey or hosts, which also might affect multitrophic interactions.

This project aims to investigate the influence of the chemical diversity of habitat odours and the complexity of vegetation structure, which are probably correlated, to plant species diversity, on a herbivore-parasitoid interaction. Furthermore we are interested in what a growing pauperization of the vegetation due to human land use means to the functionality of such an interaction in the field. Here we present the concept and the methodological approach of our project within the DFG-SPP on Biodiversity Exploratories (http://www.biodiversity-exploratories.de/).

Changes in grassland vegetation and plant species richness in the Holtumer Moor over 4 decades – implications for nature conservation.

Burghard Wittig (1), Theresa Waldmann (2) & Martin Diekmann (1)
(1) University of Bremen, Institute of Ecology and Evolutionary Biology, FB2; Leobener Str., 28359 Bremen, Germany
(2) Department of Silviculture and Forest Ecology of the Temperate Zones, Büsgenweg 1, 37077 Göttingen, Germany

The Holtumer Moor is a grassland-dominated area in the lowlands of North-western Germany. As its flora and vegetation have been studied extensively over the course of more than 40 years - first in 1963, then in a first re-inventory in 1988, and finally again in 2006 - the Holtumer Moor may serve as a representative example of the changes in semi-natural grasslands that have occurred during the past decades due to altered agricultural management.

While most of the area in 1963 was covered by species-rich meadows on moist and wet soil characterized by, among others, *Senecio aquaticus* and *Bromus racemosus*, only remnants of this community type were left in 1988 and only one site remained in 2006. The general loss in plant species richness already documented for the period 1963-1988 has continued until today. This is especially true for the intensively managed sites, but we observed a slight decrease in species number also in those sites that were continuously managed with low intensity. Grasslands that, in the framework of nature conservation measures, after a period of heavy management were transformed to less intensively used meadows or pastures, did not improve in species number. Many species still common in 1963 have completely vanished from the area, whereas "winners" such as *Alopecurus pratensis* show a strong increase in abundance. The changes in species composition and richness are well reflected in and explained by the changes in environmental conditions as indicated by the average Ellenberg indicator values.

The results demonstrate the difficulty to preserve remnants of species-rich, extensively used grasslands in an intensively used cultural landscape. We discuss possible measures to restore the former grasslands and to improve plant species richness, such as controlled introduction of species by means of hay transfer.

Identification and sustainable use of ecosystem services

4.7. Diversity and ecological role of mycorrhizal fungi in ecosystems

François Buscot, Dirk Redecker

Oral presentations

Symbiont diversity enhances plant productivity and plant diversity in grassland

Marcel van der Heijden (1) & Susanne de Bruin (2) & Ludo Luckerhoff (2)
(1) Research Station ART, Agroscope Reckenholz-Tänikon, Zurich, Switzerland.
(2) Department of Animal Ecology, Institute of Ecological Science, Vrije Universiteit Amsterdam, the Netherlands

Symbiotic interactions between plants and micro-organisms are widespread and very abundant in nature. About 150,000 plant species associate with arbuscular mycorrhizal (AM) fungi and more than 15,000 species of legumes form intimate relationships with nitrogen fixing rhizobia bacteria. In this talk, evidence will be presented showing that both AM fungi and rhizobia play a key role in natural ecosystems. We established experimental grassland microcosms and manipulated the presence of AM fungi and rhizobia in these microcosms. Subsequently, we tested the impact of AM fungi and rhizobia on plant diversity and ecosystem functioning. Our results show that: 1. AM fungi and rhizobia enhance plant productivity by stimulating growth and nutrition of their host plants. 2. Legumes require both AM fungi and nitrogen fixing bacteria to be able to coexist with other plants. 3. Symbiont diversity (e.g. the presence of both AM fungi and rhizobia) is required to reach the highest plant diversity in the grassland microcosms. Previous research showed that legumes play a key role in natural communities because of their symbiosis with rhizobia. Our results suggest that legumes not only require rhizobia to enhance plant productivity and nitrogen acquisition but that they also rely on AM fungi to have such an important functional role. Overall this work shows that plant symbionts play a key role in determining plant community structure in natural ecosystems.

Molecular evidence for life history strategies of arbuscular mycorrhizal fungi

Zuzana Sýkorová (1), Kurt Ineichen (2), Andres Wiemken (2) & Dirk Redecker (2)
(1) Institute of Botany, Academy of Sciences of the Czech Republic, Lesní 1, 252 43 Průhonice, Czech Republic
(2) Institute of Botany, University of Basel, Hebelstrasse 1, CH-4056 Basel, Switzerland

The community composition of arbuscular mycorrhizal fungi (AMF) was investigated in roots of four different plant species (*Inula salicina, Medicago sativa*, *Origanum vulgare* and *Bromus erectus*) sampled in (i) a plant species-rich calcareous grassland, (ii) a bait plant bioassay conducted directly in that grassland and (iii) a greenhouse trap experiment using soil and a transplanted whole plant from that grassland as inoculum. Roots were analyzed by AMF-specific nested PCR, RFLP screening and sequence analyses of rDNA small subunit and internal transcribed spacer regions. The AMF sequences were analyzed phylogenetically and used to define monophyletic phylotypes.

Overall, sixteen phylotypes from several lineages of AMF were detected. The community composition was strongly influenced by the experimental approach, with additional influence of cultivation duration, substrate and host plant species in some experiments.

Some fungal phylotypes, e.g. GLOM-A3 (*Glomus mosseae*) and several members of *Glomus* group B, appeared predominantly in the greenhouse experiment or in bait plants. Thus, these phylotypes can be considered r strategists, rapidly colonizing uncolonized ruderal habitats in early successional stages of the fungal community. For instance, in the greenhouse experiment, *Glomus mosseae* was abundant after 3 months, but could not be detected anymore after 10 months. In contrast, other phylotypes as GLOM-A17 (*Glomus badium*) and GLOM-A16 were detected almost exclusively in roots sampled from plants naturally growing in the grassland or from bait plants exposed in the field, indicating that they preferentially occur in late successional stages of fungal communities and thus represent the K strategy. The only phylotype found with high frequency in all three experimental approaches was GLOM A-1 (*Glomus intraradices*), which is known to be a generalist.

These results indicate that in greenhouse trap experiments it is difficult to establish a root-colonizing AMF community reflecting the diversity of these fungi in the field roots, because fungal succession in such artificial systems may bias the results. However, the field bait plant approach might be a convenient way to study the influence of different environmental factors on AMF community composition directly under the field conditions. For a better understanding of the dynamics of AMF communities it will be necessary to classify AMF phylotypes and species according to their life history strategies.

Factors influencing diversity of Arbuscular Mycorrhizal Fungi (AMF) in grassland ecosystems

S. Koenig (1), C. Renker (2), U. Langer (1), F. Buscot (1)
(1) Helmholtz Center for Environmental Research - UFZ, Department of Soil Ecology, Theodor-Lieser-Straße 4, D-06120 Halle/Saale, Germany
(2) Naturhistorisches Museum Mainz, Reichklarastraße 10, D-55116 Mainz, Germany

Several studies have shown influences of AMF community structure on plant diversity and ecosystem productivity. There is also some evidence that the vegetation, in turn, influences the diversity of AMF. However, these studies were either experiments conducted in greenhouses or, when run in natural ecosystems, they followed a descriptive approach. In the last decade some field sites with defined plant diversity were established but their research focus has not been on interaction of plant diversity and AMF.

We analysed AMF diversity in the grasslands of the Jena Experiment. There, the plant diversity is manipulated on experimental plots with different levels of species richness (1, 4, 8, 16 and 60 species). In addition, the plants are classified in four functional groups based on plant architecture, phenology and capacity for N2-fixation in the case of legumes. Using molecular tools, AMF host specificity was investigated in the soil of plots with monocultures in years 2004 and 2007. Additional analyses in plots with mixed cultures were performed in 2007 to analyse a potential relationship between increasing plant species richness and AMF community structure. In both steps of analyses, we detected a common spectrum of AMF phylotypes. The AMF community was dominated by members of the *Glomus* group A but we also detected species from *Glomus* group B, Diversisporaceae, Archaesporaceae and Paraglomeraceae, resulting in 14 phylotypes in total.

In the monoculture plots, the AMF revealed no specificity for either particular host plants or functional groups. In the plots with mixed cultures, the plant diversity appeared not to be the sole factor influencing the AMF community structure. Other significant factors were plant biomass, disturbance, presence of certain plant functional groups, and soil nutrient status. Further analysis will help to unravel the impact of these various factors on AMF community composition and to depict the hierarchical rank of plant diversity.

Arbuscular mycorrhizal fungi colonizing the roots of apple trees at semi-natural and intensively managed orchards

Hempel S. (1, 2), Schäfer T. (1, 2), Wubet T. (2), Uhlmann E. (1,2), Kaldorf M.(1, 2), Buscot F. (1, 2)
(1) University of Leipzig, Institute of Biology I, Terrestrial Ecology, Johannisallee 21–23, D-04103 Leipzig, Germany
(2) UFZ – Helmholtz Centre for Environmental Research, Department of Soil Ecology, Theodor-Lieser-Str. 4, D-06120 Halle, Germany

Many fruit tree species are dependent on arbuscular mycorrhizal (AM) infection for survival and growth. Furthermore, AM associations have been shown to reduce damage caused by soil borne pathogens. Apple trees (*Malus* x *domestica*) are usually cultivated in densely planted monocultures, potentially increasing the pathogen pressure and depleting soils of essential nutrients. In order to counterbalance these effects, intensively managed orchards are treated with high amounts of pesticides and fertilizers. In our study we compared the AM fungal (AMF) community composition between intensively used and semi-natural apple orchards throughout one growing season using molecular tools. Furthermore, we analyzed the AMF species composition on the roots of the commonly used apple root stocks “M9” and “Bittenfelder Sämling” at an intensively managed orchard to determine the effect of the root stock cultivars. In our study, members of all main groups within the AM forming Glomeromycota were detected, except Acaulosporaceae. Preliminary analysis revealed a decline of the AMF diversity found at the semi-natural orchard to the intensively managed one. A comparison of samples from the semi-natural orchard taken in spring, summer and autumn revealed a similar AMF species richness but a shift in species composition.

Mitochondrial large ribosomal subunit sequences as potential marker for population studies of *Glomus intraradices*

Boris Börstler (1), Odile Thiéry (1), Philipp Raab (2), Dirk Redecker (1)
(1) Institute of Botany, University of Basel, Switzerland
(2) IFM-GEOMAR, Kiel, Germany

Arbuscular mycorrhizal fungi (AMF) form symbioses with the majority of land plants. *Glomus intraradices* is a widespread member of this group which has been found in an extremely broad range of habitats, indicating a high tolerance for a multitude of environmental factors. Despite this ecological versatility, almost nothing is known about the local and geographic structure of this fungal species which might reveal specialized ecotypes. As the well-established marker genes of the rDNA subunits and internal transcribed spacers (ITS) display sequence heterogeneity even within single fungal spores we have developed a nested PCR approach for the mitochondrial rDNA large subunit (mtLSU). These sequences display no intra-isolate heterogeneity but different haplotypes can be distinguished among isolates of *G. intraradices*. The development of highly specific primer sets makes it possible to obtain mtLSU sequences of *G. intraradices* from colonized roots. The varying content of introns in the analyzed gene region represents a further feature to distinguish genotypes. We analyzed a set of 16 isolates of this species originating from five continents. The length of the analyzed region of the mtLSU varied among the isolates between 1070 und 3935 base pairs due to the presence/absence of introns in three locations and considerable length variation within the introns. ITS sequences were also determined from the isolates for comparisons. Some isolates differed in their ITS sequences, the mtLSU exon sequences differentiated isolates not distinguishable by ITS and the introns added further fine resolution among isolates. Comparison of the sequences to the respective regions in members of the *Glomus mosseae* group allowed additional insights into the evolution of these introns. Using specific primers and a RFLP system, the mtLSU haplotypes could be detected within colonized roots. This system is the first available tool to directly analyze intraspecific diversity of an AM fungus in the plant host. It was used to determine the haplotype diversity of *G. intraradices* in agriculturally-used and seminatural field sites.

Arbuscular mycorrhiza triggers induced plant resistance to herbivory

Anne Kempel (1), Antje Schmidt (2), Roland Brandl (2) & Martin Schädler (2)
(1) University of Bern, Institute of Plant Sciences; Altenbergrain 21, 3013 Bern, Switzerland
(2) University of Marburg, Karl-von-Frisch-Str. 8, 35032 Marburg, Germany

Mycorrhizal symbiosis has been shown to affect interactions between plants and associated organisms like pathogens and herbivores. Beside the effects of arbuscular mycorrhiza fungi (AMF) on plant growth and plant nutrition, AMF are suggested to modulate the plants defence system which may affect herbivore performance. There is evidence that AMF increase the plant's inducible resistance to natural enemies, however, the combined effects of herbivore induction and AMF on plant growth and herbivory have never been tested.

In a greenhouse experiment, we investigated the growth responses of seven herbaceous plant species to both, mycorrhization and induction of possible defences by previous herbivore feeding. To evaluate whether induced resistance is higher in mycorrhized plants we also analysed the combined effects of AMF and induction on herbivory, using bioassay caterpillars (Spodoptera littoralis).

Mycorrhiza increased plant biomass of non-induced plants, whereas this increase in plant biomass was cancelled out in induced plants. Accordingly, mycorrhization increased the performance of the herbivore only on non-induced plants but not on induced plants.

This suggests that AMF amplifies the induction of plant defences upon attack and may generate an allocation shift of the additional resources from growth to defence. We therefore conclude that mycorrhization and induction of plant defences have interacting effects on the performance of both, plants and herbivores and assume that AMF play an important role in induced plant resistance against their natural enemies.

Boreo-nemoral herb-rich forest – a new biodiversity hotspot for arbuscular mycorrhizal fungi?

Maarja Öpik (1), (2), Mari Moora (1), Ülle Saks (1), Ron Wheatley (2), Frank Wright (3), Tim Daniell (2) & Martin Zobel (1)
(1) University of Tartu, Department of Botany; 40 Lai Str., 51005 Tartu, Estonia
(2) Scottish Crop Research Institute, Errol Road, Invergowrie, DD2 5DA Dundee, UK
(3) Biomathematics and Statistics Scotland, SCRI, Errol Road, Invergowrie, DD2 5DA Dundee, UK

Boreal forest has been largely overlooked when studying diversity and ecology arbuscular mycorrhizal (AM) fungi. We described the diversity of AM fungi in a boreal herb-rich coniferous forest in Estonia. Our study site includes both old growth stands and plantations of conifers in formerly clear-cut areas. Root samples of eleven herbaceous plant species in the understorey were analysed from forest stands differing in age and forest management intensity. Plant communities, soil and light conditions were thoroughly described in order to find whether any of these factors explain the observed AM fungal community patterns. More than 30 Glomeromycota taxa, as SSU rDNA sequence groups, were detected from over 250 root samples (nearly 3000 sequenced clones). Approximately one third of the detected fungal taxa were new. Sequence groups related to *Glomus intraradices* were most common (MO-G3, MO-G13). There was host plant effect on the number of AM fungal taxa detected from root samples. We detected larger number of fungal taxa per *Hepatica nobilis* samples (3.68±0.31) than in samples of *Oxalis acetosella* (2.69±0.34). Taxon richness and composition of fungal communities were not affected by forest management and season, and fungal community composition was not affected by host plant species. Neither were fungal richness and composition explained by the described environmental variables. We conclude that this is the most taxon rich habitat in terms of root-colonising Glomeromycota described to date. These data demonstrate the importance of temperate coniferous forests as habitat for AM fungi and plants. Furthermore, the studied forest has retained its high AM fungal diversity despite common forest management practices like clear-cutting and subsequent re-planting with conifers.

Diversity of ectomycorrhizal fungal community associated to two coexisting Quercus species in a Mediterranean forest

Cristina Aponte (1), Teodoro Marañón (1), Luis V. García (1) & Monique Gardes (2)
(1) Institute of Natural Resources and Agrobiology of Seville (CSIC), Avda Reina Mercedes 10, Seville Spain
(2) Laboratoire d'Evolution & Diversité Biologique (UMR 5174), Université Paul Sabatier, 118 route de Narbonne, 31062 Toulouse Cedex 4, France

Mediterranean oak forests have a high ecologic and economic value. The sustainability these forests relies on the symbiosis established between tree species and tomycorrhizal (EM) fungal community. Oaks provide fungi with photosynthesized products that are used to generate an underground fangal network. In turn this network enlarges hosts nutrient and water foraging area and allows the exchange of resources between connected tree individuals that may be of the same or different species. In addition, oak seedlings rapidly integrate into the EM fungal network enhancing their nutrient acquisition. Therefore the EM community directly affects the productivity and regeneration of oak forest.

In Mediterraneen oak forests of southern Spain, the evergreen cork oak (Quercus suber) often coexists with the semi-deciduous Algerian oak (Q. canariensis). In the present study, we aimed to document and compare the diversity and structure of the belowground EM fungal community on root tips of the two species. As it is well recognized that it exists substantial differences in many physiological parameters such as the rate of photosynthesis, foliar nutrient content and litter decomposition between evergreen vs deciduous trees, we hypothesized that the two oak species might also differ in their mycorrhizal symbionts. We collected ectomycorrhizal root tips from individual trees of the two species in two research plots that were located approx. 40 km apart in the Alcornocales Natural Park (south Spain). Samples were collected and soils were analyzed under the canopy of each sampled tree. The fungal symbionts in root tips were identified using molecular methods (PCR amplification of the fungal ITS, sequencing and BLAST analysis). Preliminary results reveal major differences in soil abiotic characteristics between the two oak species, but not so evident are the differences between their associated fungal communities.

Poster presentations

Molecular community analysis of arbuscular mycorrhizal fungi in roots of geothermal soils in Yellowstone National Park (USA)

Susann Appoloni (1,3), Ylva Lekberg (2,4), Michael T. Tercek (2,5), Catherine A. Zabinski (2), Dirk Redecker (1)
(1) Institute of Botany, University of Basel, Hebelstrasse 1, CH-4056 Basel, Switzerland
(2) Department of Land Resources and Environmental Sciences, 821 Leon Johnson Hall, Montana State University Bozeman, MT 59717, USA
Present addresses:(3) Biolytix AG, 4108 Witterswil, Switzerland
(4) Department of Mycology, University of Copenhagen, Denmark
(5) Walking Shadow Ecology, Gardiner, MT 59030, USA

Volcanic activity in Yellowstone National Park (YNP) in the northwestern USA has caused the formation of geysers and thermal springs. In many geothermal sites, soils show an elevated temperature and altered chemistry. In those sites, plant growth is sparse and restricted to a few species, among them the grass *Dichanthelium lanuginosum*, which shows a particular capability to grow under thermal conditions.

To better understand adaptation of plants and their mycorrhizae to extreme environmental conditions, we analyzed the composition of communities of arbuscular mycorrhizal fungi (AMF) in roots from geothermal sites in YNP.

We sampled roots of *D. lanuginosum* and *Agrostis scabra* in three sites in YNP. Arbuscular mycorrhizal fungi were identified using molecular methods including seven specific primer pairs for regions of the ribosomal DNA that amplify different subgroups of AMF. Roots of *Dichanthelium lanuginosum* were sampled along with thermal and non-thermal *Agrostis scabra* and control plants growing outside the thermally-influenced sites. In addition, a preliminary sampling of roots of *Agrostis stolonifera* from geothermal areas of Iceland was performed to identify AMF common between these geographically isolated locations.

In YNP, 16 ribosomal DNA phylotypes belonging to the genera *Archaeospora* (sensu lato), *Glomus*, *Paraglomus, Scutellospora* and *Acaulospora* were detected. Six of them were new to science. The most diverse and abundant lineage was *Glomus* group A, with the most frequent phylotype corresponding to *Glomus intraradices*. Five of the seven phylotypes detected in a geothermal area in Iceland were also found in YNP. Non-thermal vegetation was dominated by a high diversity of *Glomus* group A phylotypes while non-thermal plants were not. Using multivariate analyses, a subset of three phylotypes were determined to be associated with geothermal conditions in the field sites analyzed.

In conclusion, AMF communities in geothermal soils are distinct in their composition, including both unique phylotypes and apparent generalists that occur across a broad range of environmental conditions.

Eutrophication, elevated ozone levels and arbuscular mycorrhiza in a subalpine pasture

Verena Blanke, Seraina Bassin, Matthias Volk, Jürg Fuhrer
Agroscope Reckenholz-Tänikon Research Station ART, Air Pollution/Climate Group, Reckenholzstrasse 191, 8046 Zürich, Switzerland

Nutrient-poor grasslands in the Alps are threatened by eutrophication and also by damage through high tropospheric ozone levels. To assess the impact of elevated nitrogen (N) and ozone (O_3) concentrations and their interaction on a subalpine pasture, a free-air O_3 fumigation system combined with N fertilization treatments was established in 2004 at Alp Flix (Sur, Graubünden, Switzerland; 2000 m above sea level). N enrichment increased total aboveground biomass, whereas functional groups responded differently: grasses did not react, forbs slightly increased and legumes slightly decreased in biomass. Non-mycorrhizal sedges (especially *Carex sempervirens*) benefited most from N addition and thus, their proportion increased over the years, mainly at the expense of grasses [1]. So far, there was no significant O_3 effect.

One part of the project presented here will deal with the diversity of arbuscular mycorrhizal fungi (AMF) at Alp Flix and their general role in mediating competition between local plant species. In the next step, the reaction of AMF to eutrophication and O_3 enrichment and their influence on the plant species' responses to these treatments shall be elucidated. First results are shown.

[1] Bassin S., Volk M., Suter M., Buchmann N., Fuhrer J. 2007. Nitrogen deposition but not ozone affects productivity and community composition of subalpine grassland after 3 yr of treatment. *New Phytologist* 175: 523–534.

The influence of different provenances of silver fir (*Abies alba* MILL.) on seedling performance and the diversity of its associated ectomycorrhizal fungi - a transplant experiment in the Northern Black Forest

Katrin Donges (1), Eva Cremer (2,3) (both authors equally contributed), Thomas Anastasiades (2), Gernot Nolte (1), Sascha Liepelt (2), Karl-Heinz Rexer (1), Gerhard Kost (1) und Birgit Ziegenhagen (2)
(1) Philipps-University of Marburg, Faculty of Biology, Mycology, Karl-von-Frisch-Str. 8, 35032 D-Marburg Germany
(2) Philipps-University of Marburg, Faculty of Biology, Conservation Biology, Karl-von-Frisch-Str. 8, D-35032 Marburg Germany
(3) Present address: Bavarian Institution for Forest Seeding and Planting, Forstamtsplatz 1, D-83317 Teisendorf, Germany

Climate change may force us to translocate forest reproductive material between different provenances following a predicted shift of range. Apart from the response of the respective tree species, knowledge is needed about the effects on the associated ectomycorrhiza community which has to cope with both, changed ecological conditions and symbiotic hosts of non-local or regional origin. In turn, the symbiotic effect on tree growth has to be explored under such conditions as well.

A transplant experiment was performed in the Northern Black Forest. Three provenances of silver fir (*Abies alba* MILL., one local and two far distant from Romania and Macedonia) were germinated in the greenhouse and transplanted as seedlings in a random block design into windbreak areas in the margins of mature fir stands. As a result from ANOVA and post-hoc Tukey tests, the local provenance performed best in terms of total fresh weight. In terms of shoot weight, the local and the Macedonia provenance were superior to Romania while the root weight of the Romanian provenance did not differ from both the local and Macedonian provenance. The associated ectomycorrhizal community was determined from morphological characteristics and from T-RFLP analyses of an rDNA-ITS region. The local provenance revealed the highest level of α-diversity.

The silver fir provenances were furthermore characterized by DNA microsatellite markers. Genetic differentiation was highest between the local and the two far distant ones, the latter being closely related with each other. Ongoing analyses are dealing with the question whether there was a correlation between silver fir genotypes and mycorrhization rates and associations of specific fungi.

Impact of two species of arbuscular mycorrhizal fungi on different grassland species in a greenhouse experiment

Cornelia Rißmann (1,2), Claudia Stein (1), Harald Auge (1), Stefan Hempel (3), Carsten Renker (3,4), François Busçot (3) & Daniel Prati (1, 5)
(1) Helmholtz Centre for Environmental Research - UFZ, Department of Community Ecology, Theodor-Lieser-Str. 4, D-06120 Halle, Germany
(2) Brandenburg University of Technology Cottbus, Chair of Soil Protection and Recultivation, P.O.B. 101344 , D-03013 Cottbus, Germany
(3) Helmholtz Centre for Environmental Research - UFZ, Department of Soil Ecology, Theodor-Lieser-Str. 4, D-06120 Halle, Germany
(4) Natural History Museum Mainz, Reichklarastr. 10, D-55116 Mainz, Germany
(5) University of Bern, Institute of Plant Sciences, Section Plant Ecology, Altenbergrain 21, CH-3013 Bern, Switzerland

Arbuscular mycorrhizal fungi (AMF) are the most prevalent type of mycorrhizal interactions and play an important role in ecosystems worldwide. They influence the nutrient cycle and can stimulate nutrient acquisition of their host plants. However, in some cases they can also be detrimental, due to an unbalanced carbon/nutrient exchange rate between plants and AMF. The effects of AMF on their host plants are dependent on the life strategy of the fungi. Based on different reactions on mycorrhizal colonization, structure, diversity and productivity of a grassland community can change. But it is still unknown which traits in AMF symbioses account for the different reactions of the host plants, e.g. concerning plant growth. One important trait could be the size of the extraradical mycelium.

Gigaspora margarita, for example, has a large extraradical mycelium and is able to effectively provide nutrients from soil to its host plant. Therefore *G. margarita* might be a more mutualistic partner than *Glomus intraradices* because the extraradical mycelium of the latter is only weakly developed. In a greenhouse experiment, we investigated the direct influence of the two AMF *Glomus intraradices* and *Gigaspora margarita* on different grassland species that represented four different plant functional groups. Each plant species was combined with an inoculation of either *G. intraradices*, *G. margarita*, a combination of both, field sampled inoculum or non-inoculated as control. After 16 weeks of growth the plants were harvested and their fresh- and dry-weight, height and the rates of mycorrhizal colonization were measured.

The results verified a general positive effect of AMF on plant growth and we detected differences between the functional groups of host plants. For example *Vicia cracca* and *Trifolium pratense* (Fabaceae) showed a very high increase in plant biomass when cultivated with AMF. In contrast the grasses *Holcus lanatus* and *Festuca rubra* (Poaceae) did not grow better with AMF than without. Nevertheless, there were also differences between plant species belonging to the same functional group. The hypothesis that the inoculation with *G. margarita* provides a higher increase in biomass than *G. intraradices* could not be confirmed in all cases. In contrast some host plants showed a higher fitness in association with *G. intraradices.* The varying plant responses to the different types of AMF demonstrate that the extent of the mycelium inside *versus* outside the roots is just one functional trait of AMF that could explain the influence of different AMF species on plant performance.

Identification and sustainable use of ecosystem services

4.8. EURECA – The European Ecosystem Assessment and scientific contributions to ecosystem service valuation

Ybele Hoogeveen, Carsten Neßhöver, Karin Nadrowski

Oral presentations

EURECA- The European Ecosystem assessment

Ybele Hoogeveen
European Environment Agency, Kongens Nytorv 6, 1050 Copenhagen K

Biodiversity in Europe has been significantly shaped through human interference, and this has shaped many landscapes of high conservation value. The resulting policy framework in Europe is therefore different from that in other regions or countries. A detailed assessment of Europe and its specificities was largely missing from the Millennium Ecosystem Assessment [1]. The MA follow-up strategy, as proposed by UNEP, aims at improving the knowledge base regarding ecosystem functioning and services, developing and applying tools for political decision making, and outreach to stakeholders. EURECA is intended to become a sub-global assessment within the MA-framework and will be geared towards these goals.

The definition phase of EURECA will take up most of 2008, and final deliveries are scheduled for 2012 (intermediate outputs will also be planned). This timing will allow EURECA to connect to and influence international processes such as the first assessment of the 2010 biodiversity target (CBDCOP11); the global MA-follow-up process (towards 2015), 'Rio +20' (2012) etc. Specific for Europe, EURECA will also link to the end of the 6th Environment Action Programme [3], the 2014-2020 budget decisions, and the reporting on progress with the Action Plan of the Biodiversity Communication [2] (the 7th annual report is due in 2013).

The main challenges EURECA faces are finding empirical data, addressing valuation and benefit transfer, developing assumptions and analyses for future developments, addressing multiple scales, and ensuring policy relevance. To meet this challenges EURECA will have the following elements:

- A *storyline-based assessment* of biodiversity change and its consequences for delivery of ecosystem services against the background of European trends. This entails a comprehensive analysis of state and trends of major ecosystems, followed by in-depth analyses of areas/issues of particular interest.
- An *integral accounting framework* that will allow economic assessment of ecosystem service flows across different scales. The wide consensus needed and data and analytical limitations imply that the ecosystem accounting framework is a long-term development goal. Elements of this accounting framework, however, are already operational or will become available within the timeframe of EURECA.
- Capacity building though the production of a *methods handbook*, consistent with the UNEP WCMC MA follow-up manual, and tailor-made for application at European and national scales. Guidance to all EURECA contributors will be given with regard to data needs, accounting, economic valuation, policy analysis, stakeholder process, scenario assumptions and ecosystem service terminology.

[1] Millennium Ecosystem Assessment, 2005. Ecosystems and. human well-being: Synthesis. Washington D.C.: Island Press.
[2] European Commission, 2006. Halting the loss of biodiversity by 2010 - and beyond - Sustaining ecosystem services for human well-being. COM/2006/0216 final. European Commission, Brussels.
[3] European Commission, 2002. Decision No 1600/2002/EC of the European Parliament and of the Council of 22 July 2002 laying down the Sixth Community Environment Action Programme. European Commission, Brussels.

Spatial scales and ecosystem services assessment: identifying service providing units and ecosystem service beneficiaries

Willaarts, B.A (1); Martín-López, B (2); López, E (1); Aguilera P.A (1)
(1) Departamento de Biología Vegetal y Ecología. Universidad de Almería. 04120 Almería. Spain
(2) Laboratorio de Socio-Ecosistemas. Universidad Autónoma de Madrid. 28049 Madrid. Spain

Ecosystem services (ES) are supplied at multiple spatial scales (from species to landscapes) and they are demanded by a wide range of beneficiaries (from local to global). Identifying the scale at which services are supplied and demanded is crucial for developing effective strategies for ES management.

The main objective of the current study was to quantify and map the biophysical capacity of a natural protected area in Andalusia (SW, Spain) to provide regulating services, and to identify the main ecosystem services beneficiaries (ESBs). To do so, we performed a hierarchical landscape classification of the territory based on ecological criteria to identify main service providing units (SPUs) for 5 key regulating services - micro-climate regulation, water supply, atmospheric gas regulation, soil erosion prevention, and biodiversity conservation (threatened vertebrates)-, and we quantified their biophysical capacity to supply these services. Likewise, we identified the main ESBs by making face to face questionnaires, assessing their individual preferences and the economic value they ascribed to these regulating services.

In the upper level of the landscape classification we identified 6 SPUs according to their abiotic characteristics. At a lower level, we distinguished 16 SPUs based on their biotic features and land use type. Our results showed that forest within mountain areas are the most important SPUs for hydrological services (water supply and micro-climate regulation), while shrubs of mountain valleys mostly supply two services: biodiversity conservation and prevention of soil erosion. Lastly, grasslands and extensive crops within the peneplains are the most important SPUs for atmospheric gas regulation. Overall, the spatial analysis of ES supply showed that there is a lack of spatial correlation among the most important SPUs.

We identified five ESBs – local people, local tourists, nature tourists, cultural tourists, and workers-. We found that for regulating services in general, nature tourists and workers are those who are willing to pay (WTP) more money to conserve them. While nature tourists prefer to invest money for micro-climate regulation and atmospheric gas regulation, workers prefer to invest money for soil erosion prevention and biodiversity conservation. Then, we identified the scale at which ESBs benefit from every regulating service. We found that the WTP for maintaining regulating services follows a distance-increase function, i.e. regulating services are enjoyed and valued mostly at national and international scales. At municipal scale the most important stakeholder interests relate to water supply, while at provincial scale they are linked to hydrological services. At regional and national scale, prevention of soil erosion and atmospheric gas regulation are the most valued services. Lastly, at global scale water supply and atmospheric gas regulation are by far the most valued services.

Overall, the spatial scale at which ES are being supplied is often not the same scale at which they are being enjoyed or acknowledged by the socio-economic system. Moreover, each social scale commonly comprises different ESBs, promoting sometimes conflicting interests. Therefore, consideration of the spatial ecological and socio-economic scales should support the decision-making process for ES management.

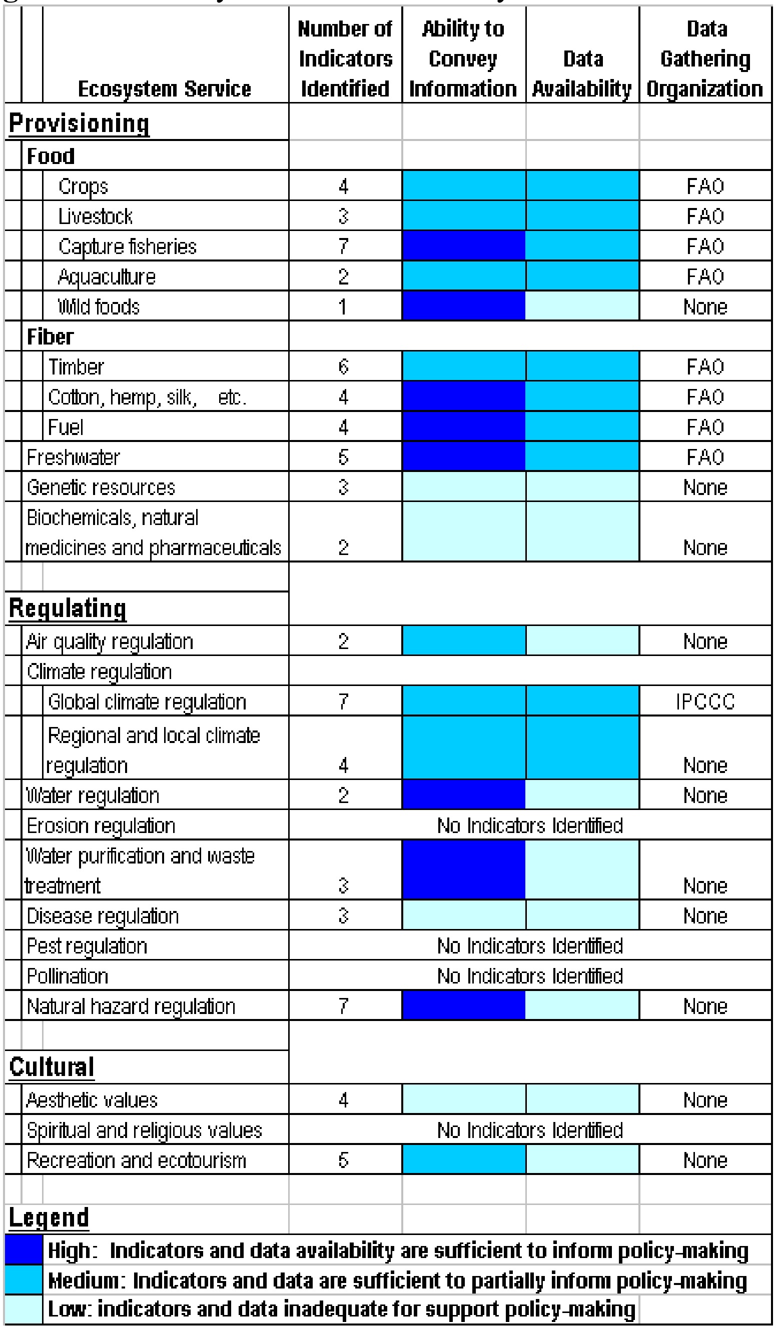
Ecosystem Service Indicators: A Case for Developing Consensus on Indicators for Assessments and Policy Input

Christian Layke (1)
(1) World Resources Institute; 10 G. St NE, Washington DC, 20002, USA

The World Resources Institute has compiled the ecosystem service indicators used in the Millennium Ecosystem Assessment (MA) and applying criteria to gauge the ability of these indicators to inform policy. Our conclusions, summarized in Table 1 and to be published in *Measuring Nature's Benefits: The State of Ecosystem Service Indicators*, are that the indicators currently available are insufficient to support incorporation of an ecosystem services approach in policy-making. The indicator weaknesses are particularly pronounced for regulatory and cultural services.

To address these weaknesses, we propose a collaboration of stake-holders seeking to expand adoption of the ecosystem service approach. We hope to include, for example, the knowledge gathered by EURECA and UNEP-WCMC's work on sub-global assessments. The collaboration will focus on reaching consensus on what indicators should be recommended for use in assessments and to inform ongoing data gathering by international bodies and national statistical bodies.

Figure 1: Summary Assessment of Ecosystem Service



Ecosystem Service	Number of Indicators Identified	Ability to Convey Information	Data Availability	Data Gathering Organization
Provisioning				
Food				
Crops	4	Medium	Medium	FAO
Livestock	3	Medium	Medium	FAO
Capture fisheries	7	High	Medium	FAO
Aquaculture	2	Medium	Medium	FAO
Wild foods	1	High	Low	None
Fiber				
Timber	6	Medium	Medium	FAO
Cotton, hemp, silk, etc.	4	High	Medium	FAO
Fuel	4	High	Medium	FAO
Freshwater	5	High	Medium	FAO
Genetic resources	3	Low	Low	None
Biochemicals, natural medicines and pharmaceuticals	2	Low	Low	None
Regulating				
Air quality regulation	2	Medium	Low	None
Climate regulation				
Global climate regulation	7	Medium	Medium	IPCCC
Regional and local climate regulation	4	Medium	Medium	None
Water regulation	2	High	Low	None
Erosion regulation	No Indicators Identified			
Water purification and waste treatment	3	High	Low	None
Disease regulation	3	Low	Low	None
Pest regulation	No Indicators Identified			
Pollination	No Indicators Identified			
Natural hazard regulation	7	High	Low	None
Cultural				
Aesthetic values	4	Low	Low	None
Spiritual and religious values	No Indicators Identified			
Recreation and ecotourism	5	Medium	Low	None

Legend
- **High: Indicators and data availability are sufficient to inform policy-making**
- **Medium: Indicators and data are sufficient to partially inform policy-making**
- **Low: indicators and data inadequate for support policy-making**

Ecosystem Approach and Assessment: Inland Danube Delta

Angheluta Vadineanu (1), Sergiu Cristofor (1), Constantin Cazacu (1), Radu Stefan Vadineanu (1), Costel Negrei (1), Carmen Postolache (1)
(1) University of Bucharest, Department of Systems Ecology and Sustainability; Splaiul Independentei 91-95, Sector 5, Bucharest, Romania, 050095

Sustainable use and development of the lotic and lentic systems, and their watersheds become a major target of the national, European and global strategies and policies for sustainable development. The Inland Danube Delta – Socio- Ecological System (IDD – SEcol.S) extends along a Danube River stretch of 215 km, between 150 and 365 km upstream from the Black Sea Coast and, between the Southern Romanian Plain, and the Dobrogean Plateau and belongs to a hierarchy of socio-ecological systems established across space within the Danube River Catchment (DRC). The approach is based on the conceptual model which identifies across space and time scales the “nature and man coupled systems” or the “socio-ecological systems” and on the analytical DPSIR frame. It focuses on the links between socio-economic drivers and pressures, changes in biodiversity, ecosystem and landscape structure, and the ability of ecosystems to provide services to the coupled socio-economic system. The case study builds upon data and knowledge base created at the Department of Systems Ecology and Sustainability, University of Bucharest, by integration of a large bulk of ecological and biological data collected by different research teams for the time period from 1900 to 1970 as well as databases produced by long term ecosystem research carried out after 1970 by a network of experts from a group of six universities and research institutes. Since 2000, the data and knowledge base has been extended through an integration of a set of social and economic parameters. The analysis and synthesis of the existing data enabled us to identify major social and economic drivers and pressures acting from local up to DRC scale and related changes in biodiversity, ecosystem and landscape structure and functions. The effects of these changes on the local level, as well as downstream in the Coastal Danube Delta and Black Sea ecosystems, have been amplified by long distance effects of drivers and pressures from higher hierarchical levels. The main structural and functional changes in the IDD as well as elsewhere in the Lower Danube floodplain have been described and assessed for the time after 1990. It was found that 50% of the area of the formerly diverse natural ecosystems of the Lower Danube floodplain and 80% of the area of the IDD were converted into agricultural land. These changes in their structural configuration brought the systems into a new functional regime that made them vulnerable to the intensification of human pressures and to extreme weather events such as floods and droughts. Under these new circumstances, our most recent estimations suggest that around 70% of the region’s total NPP was directly used by humans as intensive crops and livestock. Meanwhile, fish catches fell bellow 1 kt/yr. Similarly, the nutrient retention capacity fell below 5 kt N/yr and 0.25 kt P/yr; the flood detention capacity is now estimated to be around 1.8 km^3 of water. The support function for biological diversity has also dramatically diminished due to habitat fragmentation and destruction, food availability and eutrophication. Our case study suggests the importance of proper consideration of the multi and transdisciplinary research on the dynamic complexity within and among hierarchical socio-ecological systems **abstract too long/cut**

Challenges of Multi-Scale Ecosystem Assessments – climate change impacts from the local to the European level

Christoph Görg, Klaus Henle, Kurt Jax, Carsten Neßhöver, Cornelia Ohl, Irene Ring, & Heidi Wittmer
Helmholtz Centre for Environmental Research – UFZ, Departments of Conservation Biology, Economics, & Urban and Environmental Sociology, Permoserstr.15, 04318 Leipzig

During the follow-up process of the Millennium Ecosystem Assessment and the constitution of a Sub-Global-Assessment (SGA) working group it became evident that real Multi-Scale Assessments (MSA) addressing not only one but different scales and the interplay across them raises some particular challenges. Several environmental scales, ranging from small river catchments up to whole continents with different biomes, have to be integrated as much as research on a broad variety of socioeconomic and cultural scales, ranging from rural populations up to national and European political measures and global market forces. Particularly a MSA within Europe with its heterogeneous landscape types, its highly regulated and complex integrated socioeconomic structure, and its multi-level governance constitution create conceptual and methodological challenges. Moreover, the target audience of MSA are also complex representing decision making processes of various stakeholders on different levels.

Our contribution presents the ongoing work of developing SGA at different levels and offers conceptual steps towards integration and to make SGAs policy-relevant. It builds upon an emerging SGA at the regional level within Germany (including the LTSER-site Leipzig-Halle) and provides links towards the German national level and towards EURECA at the European level. To reduce complexity and to ensure policy relevance without losing scientific integrity, we focus particularly on climate change, because the role of climate change as a major driver of ecosystem change will presumably be predominant in the future. A range of scenarios and models of land-use change induced by climate change exist already or are under development. They show different consequences for different regions and management sectors. There is a growing need, however, to develop research on cross-scale interactions of climate change impacts from the European to the local level. Furthermore, the impact of climate change on ecosystem services presents a major concern within different levels of decision making and research on adaptation to climate change could provide valuable information to develop response strategies. Thus, to focus a MSA on climate change as a major driver has the potential to ensure policy relevance for various stakeholder groups (environmental policy, but also regional planning, agriculture etc.).

Changes of biodiversity in time and space: Connecting genetics, evolution, and processes

5.1. Adaptation processes to climate change: Innovations, dispersal and resilience

Maik Veste, Jutta Buschbom

Oral presentations

Where do plant functional traits diversify along climatic gradients?

Marie Hermant, Françoise Hennion, Igor Bartish & Andreas Prinzing
University of Rennes 1, UMR CNRS 6553 Ecobio, Av. du Général Leclerc, 35042 Rennes, France

Evolutionary biology is implicitly based on the hypothesis that species traits respond to changes in their environment. However, recent studies show that species facing climate change tend to redistribute in space in order to track their optimal environment rather than change their traits. In particular, under intermediate conditions, strong competitive interactions may prevent species from persisting in suboptimal environments and force them to redistribute. Alternatively, under extreme conditions, survival outside the optimal environment may be physiologically impossible and redistribution enforced. Trait-change may thus become either more important or less important towards the extremes of environmental gradients.

We studied the diversification of plant functional traits (foliage timing and persistence, leaf ecomorphology, flowering duration, competitiveness, stress tolerance and ruderalness) within evolutionary lineages distributed along climatic gradients (e.g. temperature, light, moisture). For each lineage, we measured variation in traits and determined correlations between mean trait values and environment. Then we analyzed how trait variation and trait/environment covariation within lineages change from intermediate to extreme environmental conditions.

First results showed that variation is higher in lineages occupying intermediate climatic conditions than in lineages occupying extreme environments. This indicates that diversification of plant functional traits is promoted by intermediate environmental conditions. The relative contribution of different climatic gradients to the diversification of traits has changed during evolution. While intermediate temperature conditions were particularly important for trait diversification within families, intermediate light conditions were particularly important at genus level. Intermediate environmental conditions, while relatively unspectacular for many conservation biologists, may thus play an important role for biota to adapt traits to environmental change.

Climate change effects on the competitive ability of European beech at its northern range margins in southern Sweden

Andreas Bolte (1,3), Britt Grundmannr (2), Lutz Hilbrig (1), Friederike Kampf (3), Stephan Bonn (2), Andreas Roloff (2)
(1) Johann Heinrich v. Thünen-Institute (vTI), Institute of Forest Ecology and Forest Inventory, Alfred-Möller-Straße 1, 16225 Eberswalde, Germany
(2) Technical University of Dresden (TUD), Institute of Forest Botany and Forest Zoology, Pienner Str. 7, 01737 Tharandt, Germany
(3) University of Göttingen, Faculty of Forest Sciences, Department of Silviculture and Forest Ecology of the Temperate Zones, Büsgenweg 1, 37077 Göttingen, Germany

Today, European beech (*Fagus sylvatica* L.) seems to be a markedly successful tree species in the centre and the north of its distribution range; its range is believed to be larger than originally assumed. At the northern range margins of beech in southern Sweden, mean annual air temperature has raised about 1°C during the past 100 years and an extended growing season may favour the competitive ability of European beech compared to dominating Norway spruce (*Picea abies* (L.) Karst.) that is more threatened by likely more frequent storm and drought events due to climate change.

In three Swedish mixed old-growth forests with spruce and beech at nature reserves in Rågetaåsen/Halland, in Siggaboda/Smaland and in Tolseboda/Blekinge, stand structure with tree position, dbh, height and crown characteristics were studied as well as stem diameter growth using tree-coring analyses. This was done in 1 ha-core plots in the centre of each forest reserve. Sequential stand structure recordings at Siggaboda reserve in the years 2004, 2005 and 2007 allowed insights in the stand dynamics due to the "Gudrun" hurricane in January 2005 (Figure 1), the drought in summer 2006 and the subsequent bark beetle attack on spruce in 2007. The hurricane, which caused disastrous damage in many stands nearby, had comparatively little impact on the structure of the spruce-beech stand. All together, only 35 trees (17 spruce trees, 13 beech trees, 5 trees of other species) per hectare were uprooted or damaged by the storm; this represents 7% of the total tree number. Diameter and height structure have changed insignificantly. However, the 2006 drought and the 2007 bark beetle attack have changed stand structure and composition strongly due to the death of about one fifth of the dominating old spruce tree collective. This results in a significant increase of beech's contribution to stem number and wood volume of the living stand. A comparison of diameter growth of European beech and Norway spruce during the periods 1894-1949 and 1950-2005 at Siggaboda and Tolseboda reserve showed a distinct decrease of growth superiority of spruce in the last 50 years. These results support the idea of a northward migration of European beech as a nemoral tree species in Sweden based on a higher tolerance to abiotic and biotic threats of climate change and an increased competitive ability compared to boreal tree species like Norway spruce.

Figure 1: Storm damages at Siggaboda reserve (year 2005)

Effects of extreme weather events on plant productivity and competitive balance among species

Kerstin Grant (1), Juergen Kreyling (2), Carl Beierkuhnlein (2), Anke Jentsch (1)
(1) Disturbance Ecology and Vegetation Dynamics, Helmholtz Centre for Environmental Research – UFZ, Permoserstr. 15, D-04318 Leipzig, and University of Bayreuth, D-95440 Bayreuth, Germany
(2) Biogeography, University of Bayreuth, D-95440 Bayreuth, Germany

The effects of extreme weather events, which are increasing in frequency and magnitude, on vegetation are mostly unknown. Within the climate change experiment EVENT (Jentsch et al. 2007), we determined the impacts of local 100-year recurrent drought and heavy rainfall events on the aboveground productivity of experimental grassland communities and the competitive balance among five species. Furthermore, we analysed the role of functional diversity and the presence of legumes in buffering effects of extreme weather events.

For quantifying the competitive balance of the single species, the mathematical indices relative neighbour effect (RNE), relative crowding (D_r') and interaction strength (I) were calculated on base of biomass data derived from aboveground harvests and / or cover estimates. Analyses of variances and linear mixed effects models were chosen to reveal differences between the weather manipulations.

Overall productivity of the grassland communities remained stable in face of extreme drought and heavy rainfall, despite significant weather effects on the species level. No significant evidences for facilitation under drought were found but there was a trend to higher competitive neighbourhood under heavy rain. The stable productivity of grassland communities but varying response on species level support the insurance hypothesis.

Local adaptation in microbes: Temperature reaction norms and genetic structure of *Paramecium caudatum*

Sascha Krenek, Dana Barth, Martin Schlegel and Thomas U. Berendonk
University of Leipzig, Institute of Biology II, Molecular Evolution & Animal Systematics, Talstr. 33, 04103 Leipzig, Germany

Temperature is one of the most important environmental factors determining the physiological performance of small and fast reproducing organisms of aquatic ecosystems like protozoans. But it is not well understood, if such microorganisms can acclimate phenotypically to the expected temperature increase due to climate change.

For this study, we isolated *Paramecium caudatum* cells from different freshwater habitats throughout Europe in a north-south gradient. Furthermore, we have collected cells from tropical habitats (Indonesia) as genetic and phenotypic outgroup. To examine the genetic background of these *P. caudatum* isolates we have molecularly characterised these, using the mitochondrial cytochrom *c* oxidase I (COI) gene and performed phylogenetic analyses in order to investigate a possible correlation of geographic and genetic distances. In addition, we ascertained the temperature reaction norms for these clones, within a temperature range from 7°C to 35.5°C.

Our data demonstrate on the one hand no correlation of geographic and genetic distances and on the other hand that the investigated clones showed different temperature reaction norms, which did not correlate with the geographic origin of the isolates, except for the tropical strains. These formed a distinct genetic cluster and showed a warmer temperature optimum than all European isolates.

This suggests that selection for temperature may act at larger geographic scales or only to very specific local habitat conditions.

Growing tall *vs.* Branching out? - Temperature dependent changes of plant architecture

Säumel, I. and Kowarik, I.
TU Berlin

Phenotypic plasticity as an adaptive strategy of response to environmental factors involves both morphological and physiological changes. As a result of ongoing global warming, a main challenge for plants is the adaptation to warmer, and often dryer, environments. We studied temperature effects on plant architecture and biomass allocation of the Chinese *Ailanthus altissma*, the North American *Acer negundo* and the European *Acer platanoides*, using destructive and non- destructive growth analysis.

The saplings were exposed to three day/night temperature regimes (10/5°C, 15/10°C and 20/15°C). We observed changes in intra-sapling resource allocation, such as alterations in stem and root growth, branching patterns, leaf number, leaf morphology and leaf arrangement. The species showed differing sensitivity to ambient temperatures, suggesting differences in overall ecophysiological plasticity. Performed changes in plant architecture may underline adaptive advantages for *Acer negundo* vs. disadvantages for *Ailanthus altissima* in colder habitats. *Acer platanoides* was mostly unresponsive to temperature on the morphological level.

The observed phenotypic plasticity of the species contributes to understand species'distribution patterns and to predict invasion processes in the future warmer world.

Poster presentations

Population genetics in different contexts: Impacts of altitude & landscape structure

Thomas Hahn, Andrea R. Pluess, Chris Kettle & Jaboury Ghazoul
ETH Zürich, ITES - Ecosystem Management, Universitätsstr. 16, 8092 Zürich, Switzerland

Plant population responses to a changing climate included; plasticity, adaptation, migration and extinction. The evolutionary potential and pre-adaptation of a population is highly dependant on its genetic diversity and differentiation, which in turn is a function isolation and landscape context. Along an altitudinal gradient it is assumed that upper peripheral populations are smaller and more isolated than lower central populations. On the other hand, the arrangement of landscape elements, acting as barriers or corridors for gene flow influences genetic patterns within metapopulations.

In my PhD project I will study whether upper peripheral populations compared to central populations are genetically depauperate and more differentiated. Moreover, I will investigate how landscape structure, altitude and wind affect directions and quantities of gene flow in metapopulations. Population genetic differences within ten pairs of central and upper peripheral populations will be investigated in the species *Trifolium montanum*, *Ranunculus bulbosus* (both insect-pollinated) and *Briza media* (wind pollinated), which are common in Switzerland. Populations of the aforementioned species will be sampled in Central Switzerland and genotyped using AFLP analyses.

As part of the ETH CCES-BioChange program these results will be directly integrated with two other PhD projects within the Ecosystem Management group at ETH. These aim at studying (1) local adaptation and phenotypic plasticity of core vs. peripheral populations (Esther Frei) and (2) disruption of local adaptation by pollen immigration (Philippe Matter). Results from the CCES-BioChange program are intended to provide a scientific basis for conservation of evolutionary potential, adaptation and phenotypic plasticity of populations in the face of climate change.

Distribution and spread of the wasp spider (*Argiope bruennichi*) in Europe

Sabrina Kumschick (1),Stefan Fronzek (2), Martin H. Schmidt (1) & Wolfgang Nentwig (1)
(1) University of Bern, Zoological Institute, Baltzerstrasse 6, 3012 Bern, Switzerland
(2) Finnish Environment Institute, Mechelininkatu 34a, 00251 Helsinki, Finland

The wasp spider (*Argiope bruennichi*) originally comes from the Mediterranean part of Europe and occasionally was found in warmer regions of central Europe. In the second half of the 20th century, the spider started to spread and to expand its range northwards. There are a few studies which describe the spread in several countries, but a continent-wide survey of this spread is lacking. Furthermore, not much has been done to analyse the reason for this spread. We collected data of the distribution of the wasp spider over time for most European countries and correlate this with climate (temperature, precipitation, …) at that time. We will report on how the spread of the wasp spider is correlated with climate and its change. In addition, we analyse the question up to which degree this spread is also triggered by anthropogenic changes of landscape use since *A. bruennichi* is restricted to some types of habitats and benefits from habitat disturbance.

Ecological adaptations in Southern African Aizoaceae - linking ecophysiology, systematics and evolution

Maik Veste (1) & Joachim Thiede (2)
(1) Brandenburg University of Technology, Research Centre for Landscape Development, Konrad-Wachsmann-Allee 6, D-03046 Cottbus, Germany
(2) University of Hamburg

A large number of succulent species and a high biodiversity are typical for the arid and semi-arid zones of Southern Africa. The iceplant familiy, Aizoaceae (including Mesembryanthemaceae) developed a huge variation with more than 1750 species with a biodiversity hotspot in the Succulent Karoo. The evolutionary background and origin of the C3 and CAM photosynthesis for the Aizoaceae are projected on the phylogeny of the family based on molecular data [1, 2] (Fig. 1). In the most basal subfamilies Sesuvioideae, Aizooideae and Tetragonioideae only C3 photosynthesis is known. Within the Mesembryanthemoideae, *Mesembrynathemum* hold a basal position and a shift from C3 to CAM under a strict ontogenetic control in observed. The other perennials in this group (e.g. *Brownanthus*, *Dactylopsis*) exhibit a typical CAM. There is some evidence that the CAM-cycling may be interpreted as an intermediate step in the evolution of CAM in this family. Species of Mesembryanthemoidae showed a high accumulation of Na and Cl compared to the Ruschioideae [3]. The highest salt accumulation can be found e.g. in *Opophytum aquosum, Mesembryanthemum* and *Brownanthus.* Furthermore, in the genus *Brownanthus* ions pattern can be linked to plant systematics.

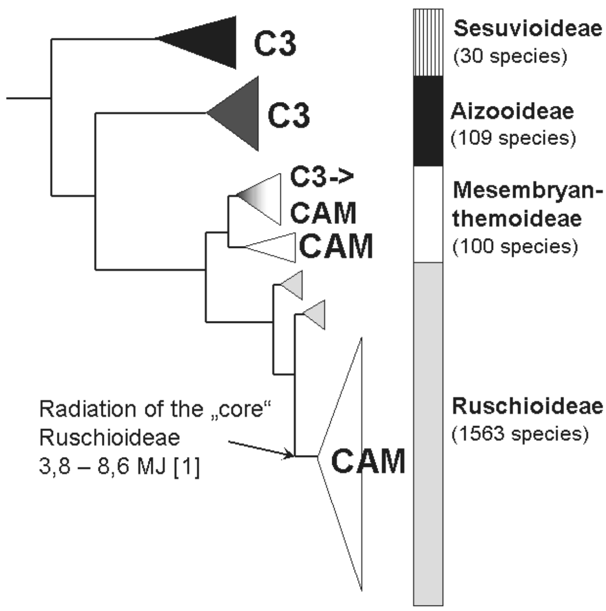


Figure 1: Schematic diagram of the phylogeny of the Aizoacae [1,2] and the photosynthetic types.

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Changes of biodiversity in time and space: Connecting genetics, evolution, and processes

5.2. Evolutionary Ecology

Daniel Prati, Oliver Bossdorf

Oral presentations

Modelling adaptation and extinction risk in a changing World: Understanding the role of phenotypic variance

Richard Walters (1), Calvin Dytham (2), Frank Schurr (1) & Florian Jeltsch (1)
(1) University of Potsdam, Plant Ecology and Nature Conservation, Maulbeerallee 2, D – 14469 Potsdam, Germany
(2) University of York, Department of Biology, PO Box 373, York, YO10 5YW, UK

In a changing World species must adapt, move or die. Fossil and pollen records suggest that during past climate changes species, and whole communities, largely avoided extinction by migrating. What cannot be easily deciphered from such paleontological data, however, is any evidence of eco-physiological or life-history adaptations that might also have been necessary during such a transition. Given a potentially unprecedented rate of predicted climate change due to global warming and increasing habitat loss and fragmentation, a better understanding of species' potential for adaptation is now urgently required.

Heritable variation is necessary for adaptation, and to this extent a higher genetic variance reduces the possibility of extinction. However, whether a species can successfully adapt is also dependent upon its life history and resulting population dynamics. Using a quantitative population genetics model we illustrate how extinction risk associated with environmental change, and the rate of change, is dependent upon fecundity and total phenotypic variance. Highly fecund species are able to produce, through recombination, a greater number of adapted variants per generation, thereby reducing selection intensity and effects of a small population size e.g. inbreeding, while evolving to a new environmental equilibrium. If the rate of change exceeds the rate at which genetic linkage can be broken down, non-genetic variance (due to environmental and developmental sources) can play an important role in reducing extinction risk by maintaining a viable population size until adaptive recombinants can be produced.

Life-history evolution in a changing world

Thomas S. Hoffmeister (1), Louise E.M. Vet , Patrick Coquillard (3)& Eric Wajnberg (4)
(1) University of Bremen, Population Ecology Lab; Leobener Str. NW2, 28357 Bremen, Germany
(2) NIOO Centre for Terrestrial Ecology, Boterhoeksestraat 48, 6666 ZG Heteren, The Netherlends
(3) Université de Nice, Université de Nice-Sophia-Antipolis, Parc Valrose, Nice cedex 2 06108, France
(4) I.N.R.A., 400 Route des Chappes, BP 167, 06903 Sophia Antipolis Cedex, France

Global environmental changes include the fragmentation of habitats as well as their stability within and across seasons. For instance, imagine a large continuous environment with more or less constant resource availability contrasted with habitat islands in which, due to seasonal fluctuations, resources might be present at one time and absent at other times. The latter allows animals to forage locally in one generation but forces them to disperse to other such habitat islands in other generations. In such a situation, many insects that forage for oviposition resources like butterflies searching for host plants and parasitoid wasps hunting for host insects face the dilemma that they need to trade-off fecundity against the lifetime they can invest into foraging for oviposition sites. Using evolutionary algorithms we analysed optimal trade-offs for insects facing different environments, and the optimal plasticity – the capability of adjusting the fecundity-survival trade-off within a lifetime – when such plasticity is costly. Additionally, we explored the effect of competition on these life-history strategies.

Experimental evolution in an insect-fungus interaction

Marko Rohlfs
University of Kiel, Zoological Institute; Am Botanischen Garten 1-9, 24098 Kiel, Germany

Microorganisms are considered to be important decomposers, pathogens and mutualists in almost all ecosystems. Recent studies, however, suggest that they can also function as consumers and competitors of animals if they have harmful effects on larger consumers developing on energy and nutrient rich resources such as carrion, dung, fruits, and seeds that are critical to growth and reproduction of both animals and microbes [1-3]. We recently discovered that there is in the wild genetic variation for developmental success of saprophagous Drosophila flies in the presence of competing filamentous fungi [4], which may lead to adaptive changes in insect populations exposed to fungal competitors. To test this hypothesis, we have designed an artificial selection experiment in which we subjected replicated populations of Drosophila melanogaster to the impact of the common mould Aspergillus nidulans. After five cycles of confrontation with fungus-infested larval feeding substrates, selected populations had higher post-emergence adult survival and higher fecundity than unselected populations when larvae had fed on mould-infested substrate. We present data on correlated responses to this evolved fungus resistance, which may represent costs to the improved insect performance under mouldy conditions. Such costs may contribute to the maintenance of genetic variation in traits determining the outcome of this insect-fungus interaction. Our study demonstrates that competitive insect-fungus interactions can changes the genetic structure of animal populations and thus whether significant energy resources are solely open to the detrital pathway or whether animals facilitate energy and nutrient fluxes to higher trophic levels.

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The role of fungal chemical diversity in an antagonistic insect-mould interaction

Monika Trienens & Marko Rohlfs
Christian-Albrechts-University of Kiel, Institute of Zoology – Animal Ecology; Am Botanischen Garten 1-9, 24098 Kiel, Germany

Since both filamentous fungi and saprophagous insects use food-falls, e.g. fruits, as a hub for growth and reproduction, these taxa have been demonstrated to be competitors for this food source. Insect larvae of *Drosophila melanogaster* suffer from high mortality, which depends on the fungal species (*Aspergillus* ssp.) and the developmental state of the fungus, but the insects can hamper fungal growth when they feed at high larval densities. The outcome of the interaction between these species has been suggested to be influenced by a number of toxic secondary metabolites fungi secrete into the larval feeding substrate. We argue that fungal secondary metabolites operate in terms of a defence system against insect competitors to mitigate impairment due to the insects' feeding and roving activity. We tested this hypothesis, by using fungal mutants that have a loss-of-function mutation in the global regulator gene *laeA* that has been shown to positively regulate expression of various secondary metabolites, including insecticidal mycotoxins. We compared the effect of wildtype and mutant strains of three *Aspergillus* species on density-dependent mortality of *D. melanogaster* larvae and on the reproductive success of the fungi when confronted with insect larvae. We found strong fungus-specific effects on both insect and fungal development; for instance, knocking out *laeA* in *A. nidulans* led to improvement of insect development, whereas the negative effect of *A. flavus* and *A. fumigatus* was only mildly reduced. Possibly, *laeA* regulates different secondary metabolite cluster in different fungi or *A. flavus* and *A. fumigatus* are able to circumvent the loss-of-function mutation by activating alternative mycotoxin biosynthesis pathways. This ecological genomic approach may help identifying candidate genes in insect-fungus interactions and better understanding the evolution of highly toxic compounds in fungi.

Underwater gourmet: Prey finding and prey choice by the freshwater leech *Erpobdella octoculata* using foraging kairomones

Agnes Stempniewicz (1), Beate Baier (2), Johannes L.M. Steidle (1)
(1) Universität Hohenheim, Fg. Tierökologie 220c, Garbenstr. 30, 70593 Stuttgart, Germany
(2) Institut für Hygiene und Umwelt, Marckmannstr. 129b, 21033Hamburg, Germany

Chemical signals which transfer information between species, so-called allelochemicals (Dicke & Sabelis, 1988), play an important role for the structure of ecosystems [1]. This is especially true for foraging kairomones, which are used by predators, parasitoids, parasites and herbivores to locate their food and hosts [2]. So far, foraging kairomones have been studied mainly in terrestrial ecosystems and only little in aquatic ecosystems. Recent work from our group indicates that the freshwater leech Erpobdella octoculata uses foraging kairomones to locate dead specimen of Tubifex tubifex, Chironomus sp., and Asellus aquaticus [3].

Laboratory studies from the present study revealed that *E. octoculata* prefers chemical signals from freshly killed *T. tubifex* over those from *Chironomus sp.* and *A. aquaticus* throughout the year. The strength of the reaction varied depending on the season. To examine the reason for this preference, benthic organisms were sampled from the Körsch brook near Stuttgart where the experimental *E. octoculata* have been collected. Depending on season, the dominant species were either Oligochaeta or *Gammarus sp.* followed by *Chironomus* sp. In preliminary feeding experiments, leeches were not able to find, handle or swallow *Gammarus sp.* and *A. aquaticus*. The handling time to overwhelm and swallow *Chironomus sp.* was longer than for *T. tubifex*. Thus, prey abundance and ability to deal with their prey agrees with the preference of *E. octoculata* for *T. tubifex*. However, much more studies are required to explain the preference of leeches for chemical signals of *T. tubifex* over those from *Chironomus sp.* and *A. aquaticus.*

Chemical analyses to identify the foraging kairomones reveal that *Chironomus sp.* and *T. tubifex* release distinct patterns of amino acids into the water. Future experiments will have to demonstrate if these amino acids can be responsible for prey finding and prey selection of *E. octoculata*.

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Life history strategies, foraging patterns, and host plant benefit in the arbuscular mycorrhizal symbiosis

Jeff R. Powell (1), Miranda M. Hart (2), Matthias C. Rillig (1) & John N. Klironomos (2)
(1) Freie Universitaet Berlin, Institut fuer Biologie, Altensteinstr. 6, 14195 Berlin, Germany
(2) Department of Integrative Biology, University of Guelph, Guelph, ON, Canada

Arbuscular mycorrhizal (AM) fungal species differ in a number of life history characters (rapid versus slow colonization) and foraging patterns (intraradicle/extramatrical hyphal growth) that influence growth habits. There appears to be significant phylogenetic signal in the distribution of traits among taxa [1-3]; therefore, direct comparisons of these variables among taxa is not a valid approach to characterizing the functional contributions of these variables. Here, we use phylogenetically independent contrasts [4] to estimate correlations among life history characters and foraging patterns of 14 species of AM fungi, colonizing four plant species, in an attempt to detect trade-offs in growth strategies and the influence of these strategies on host plant benefit. AM fungal evolutionary relationships were derived from published phylogenies and, for unresolved taxa, Bayesian analyses of rRNA sequences. Correlations were robust to polytomies in the phylogeny. No apparent trade-offs associated with colonization of roots versus soil were detected. Rate of root colonization (number of days to initiate root colonization) was a significant predictor of eventual abundance within the root (% root length colonized); however, rate of soil colonization (number of days to maximum growth rate) was not correlated with eventual abundance in soil (eventual hyphal length). Estimates of host plant benefit (host plant biomass, plant tissue [P]) were positively correlated with soil hyphal length and, to a lesser extent, percent root length colonized. Investments in colonization of the soil environment had no apparent effect on colonization of the root environment, but did have consequences for the success of host plants. We are currently investigating the effects of foraging patterns on other functional characteristics of the AM fungal symbiosis, including soil aggregation and interactions with fungal pathogens. We are also estimating evolutionary and ecological components of variation, as previous research suggests that outcomes of symbiotic interactions are strongly dependant on the taxonomic identities of the symbionts [2,5]. Future research into the behavioural ecology of AM fungi will require identification of groups of attributes that co-vary independently of phylogeny.

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Epigenetics, endophytes, and other things that irritate plant evolutionary ecologists

Oliver Bossdorf
University of Bern, Institute of Plant Sciences, Altenbergrain 21, CH-3013 Bern

A basic assumption in plant evolutionary ecology is that phenotypic variation observed among natural populations is either a result of underlying genetic variation or of phenotypic plasticity. Thus, common garden studies can be used to disentangle genetic effects from phenotypic plasticity: if phenotypic variation disappears in a common environment, this is evidence of phenotypic plasticity; if it persists and related individuals continue to be more similar, this is indirect evidence of genetic variation. However, in reality the situation is not that simple. There are several additional processes that can cause persistent phenotypic variation among plants, even in the complete absence of genetic variation. Among others, heritable variation in ecologically important traits can be caused by maternal environmental effects, by heritable epigenetic variation, and by vertically transmitted endophytic fungi. I will briefly summarize what is known about these processes, why it is important for evolutionary ecologists to take them into account, and how this could be done in practice.

Flower visitors and transfer of pollen analogue in six species of Justicia (Acanthaceae)

Alexander N. Schmidt-Lebuhn (1), Paola S. Pozo Inofuentes (2), Michael Kessler (3)
(1) Abt. Pflanzenökologie, Inst. für Biologie, Univ. Halle-Wittenberg, Germany, schmidtleb@yahoo.de
(2) Instituto de Ecología, Universidad Mayor de San Andrés, La Paz, Bolivia
(3) Abt. Systematische Botanik, A.-von-Haller-Inst. für Pflanzenwissenschaften, Univ. Göttingen, Germany

Figure 1: *Justicia glutinosa* (above) and *J. monopleurantha* (below), two of the study species.

While the effect of pollinator shifts on genetic isolation and speciation has received relatively much attention, comparatively little is still known about the long-time effects of the behaviour of different pollinator guilds on gene flow and genetic structure of the species depending on them [1]. To test the hypothesis of divergent behaviour of the visitors of melittophilous (bee-pollinated) and trochilo-philous (hummingbird-pollinated) plants, we selected three species of Bolivian *Justicia* for each of both syndromes to conduct field studies. Like most Acanthaceae, *Justicia* species are usually euphilous, i.e., exhibit a high degree of specialization in characters usually associated with pollination syndromes (corolla shape and size, colour scheme, position of anthers, nectar [2], etc.).

Experiments consisted of three parts: observation of flower visitors and their behaviour in one-hour-shifts from dawn to dusk to test the applicability of the pollination syndrome concept; collection of nectar samples for later analysis; and powder dye tracking experiments. For the latter, anthers of five flowers of a focal plant were dusted with fluorescent powder dye. 24 hours later, stigmata of all open flowers of the population were checked for presence or absence of the powder, and their distance from the focal plant was determined.

Preliminary results of the powder dye tracking experiments show significant differences in pollinator performance between melittophilous and trochilophilous species, a fact that should be expected to have profound effects on genetic population structure.

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Florivores decrease flowering duration

Virve Sõber, Tiit Teder, Mari Moora
Institute of Ecology and Earth Sciences, University of Tartu, Lai 40, 51005 Tartu, Estonia

Since variation in flowering phenologies yields to different reproductive success, timing, duration and synchrony of flowering should be shaped by natural selection. Abiotic factors and pollinator availability have been shown to affect the evolution of flowering phenologies of animal-pollinated plants. There is growing, yet scarce however, evidence of significant influences of biotic non-pollinator selection agents, such as florivores.

To assess the effect of florivory on flowering duration, we recorded the beginning and duration of flowering of 139 self-incompatible, insect-pollinated biennial *Verbascum nigrum* individuals in five natural populations. During flowering, we repeatedly recorded the number of larvae of a specialised florivorous weevil, *Cionus nigritarsis*, on the inflorescences of the study plants.

We found a strong negative correlation between the duration of flowering and the level of florivory, i.e., the number of florivores per flower. The flowering duration of the plants with the highest levels of florivory was about three times shorter compared to the plants with the lowest levels.

Three possible mechanisms may have contributed to the observed flowering pattern. The behaviour of plants may be adaptive (1): a plant, while attacked by florivores, may speed up flowering. It is likely that plants may be able to reduce the negative impact of florivores by synchronising flowering. Some unknown non-adaptive physiological reactions (2) of plants may occur in response to the presence of florivores. We cannot, though, exclude that the decrease in flowering duration may be mechanistic (3), i.e., high numbers of florivores simply turn a many-flowered plant into a few-flowered one by destroying the flowers. However, the latter is unlikely, since the absolute decrease in flowering duration in response to the level of florivory was unproportionally high for the mechanistic explanation to be solely responsible for the observed pattern.

Our results indicate that the negative impact of florivores on plant reproductive success may be dual. In addition to flower destruction, they reduce flowering duration and thereby the exposure of flowers to pollinators.

Relationship between plant defence syndromes and herbivore performance

Caroline Müller (1), Nora Travers-Martin (2)
(1) University of Bielefeld, Department of Chemical Ecology, Universitätsstr. 25, D-33615 Bielefeld,
(2) Julius-Kühn-Institute, Geilweilerhof, 76833 Siebeldingen, Germany

Plants use different strategies to fend off antagonists by chemical and mechanical means or avoidance mechanisms. According to the plant defence theory these traits are predicted to covary across taxa. Agrawal and Fishbein [1] grouped plants of the Asclepiadaceae according to their edibility and defence status into three syndromes: 'low nutritional quality', 'nutrition and defence', and 'tolerance/escape'. Herbivores that are able to feed on the differently defended plant species must have evolved mechanisms to tolerate these putative defences and can even use plant metabolites as own chemical weapons against predators. Their performance and preference behaviour on various plant species might mirror the putative defence syndromes of the host plant species to some extent. Seven species within the Brassicaceae and the herbivorous turnip sawfly *Athalia rosae* (Hymenoptera: Tenthredinidae), which is specialised on Brassicaceae, were used to test this hypothesis, applying multivariate statistics. Thereby, young and old leaf tissues were analysed separately, as values of chemical and mechanical defences can vary drastically even within one species.

Plant species could be grouped in the clusters already described for Asclepiadaceae, demonstrating that the concept of the plant defence syndromes might have a wide application, however, with some modifications. Plant species characteristics were either low nutritional quality or higher nutritional quality together with either chemical or mechanical defences. Young and old leaves within a given species grouped within the same syndrome, despite the differences in quantities of defences. The sawfly *A. rosae* uses the plant glucosinolates, characteristic metabolites of the Brassicaceae, for its own defence against predators. The performance pattern of larvae on the different plant materials matched well, but not entirely, with the clusters forming plant syndromes. Consistent with predictions on specialist herbivores, performance and preference of this insect were mainly influenced by mechanical and less by chemical plant defence traits. The concept of plant defence syndromes together with data on the long-term performance and preference of a specialist herbivore in relation to these syndromes revealed putative general implications for the evolution of plant-insect interactions.

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Putative host switch by a specialised herbivorous beetle to a neophyte?

Anne Kühnle & Caroline Müller
University of Bielefeld, Department of Chemical Ecology; Universitätsstr. 25, 33615 Bielefeld, Germany

Phaedon cochleariae, the mustard leaf beetle (Coleoptera: Chrysomelidae), is specialised on various Brassicaceae in Europe and Asia [1]. It is known that chemical compounds in methanolic extracts of mustard host plants, specifically glucosinolate- and flavonoid-containing fractions, stimulate their feeding behaviour [2]. The Brassicaceae *Bunias orientalis* got introduced from South-East-Europe and West-Asia to North- and West-Europe in the 18th century and can be considered as invasive plant in North- and West-Europe in recent years [3, 4]. The potential for host plant acceptance of this new putative host was tested for a German population of the mustard leaf beetle.

Third-instar larvae and adults were able to feed and to survive on *B. orientalis* leaves, but preferred to feed on other Brassicaceae if given the choice. Females even deposited eggs on this plant, although all larvae that hatched from these eggs died. Therefore, cues that mediate the host plant choice were evaluated in detail.

In olfactometer assays the odour of leaves of *B. orientalis* was attractive for both female and male adults of *P. cochleariae*. To elucidate the role of chemical contact cues, extracts of *B. orientalis* leaves were prepared in solvents of different polarity and further fractionated. Both extracts and fractions were presented in feeding bioassays to adult *P. cochleariae*. Deterrent and stimulatory effects were investigated by coating host and non-host plants with these plant compound mixtures of *B. orientalis*. A methanol extract and its pure water fraction stimulated feeding by *P. cochleariae*, whereas its pure methanol fraction was slightly deterrent. Further investigations by semi-preparative high performance liquid chromatography revealed that the stimulatory fraction contains glucosinolates. The identities of stimulatory as well as deterrent components remain to be elucidated.

The results suggest that currently *B. orientalis* is not a suitable host plant for the tested population. But if this neophyte spreads further and the encounters with *P. cochleariae* increase, a host switch to *B. orientalis* can not be excluded, if neonate larvae (physiologically) adapt to the plant's chemistry.

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Is there evidence for adaptive processes in invasive *Acer negundo* populations?

Alexandra Erfmeier, Martin Böhnke & Helge Bruelheide
University of Halle, Institute of Biology / Geobotany and Botanical Garden, Am Kirchtor 1, 06108 Halle, Germany

Ecotypic differentiation between populations is a common mechanism of plant species to cope with environmental variation between populations. Such variation in habitat types can thereby lead to local adaptation also on relatively short geographical distances. The relative role of adaptive processes is particularly of interest for invasive plant species, which encounter different environments while successfully colonizing a new range. However, the ability to exhibit plastic responses is an often opposing alternative to cope with different environments, particularly for successful invaders.

The dioecious tree *Acer negundo* (Aceraceae) is one of the most invasive woody plant species in Central Europe primarily in wet habitats along riversides and in floodplains. Introduced to Central Germany at the end of the 17th century, *Acer negundo* increased its abundance notably in dry habitats during the last decades and, nowadays, it can also be found in dry industrial wasteland and on ruderal sites.

In the present study, we focused on invasive *Acer negundo* populations in the region of Halle, Saxony-Anhalt. A total of 21 invasive populations were chosen both from wet and from dry habitats to test the hypothesis of evolutionary adaptation to drier site conditions. We conducted a greenhouse experiment with seedlings of each five seed families per population subjected to four different soil moisture regimes to test for genetic differentiation with respect to water supply. Local adaptation was studied in a reciprocal transplant experiment in the field with each 30 seedlings originating from each five dry and each five moist populations. For all transplants, we recorded survival and growth over one year.

Both, factorial analysis of habitat type effects as well as home/away contrasts provided only weak evidence for genetic differentiation and adaptation of *Acer negundo* invasion and suggest that the ability of plastic responses still seems to be crucial for *Acer negundo* invasion. Anyhow, there is also reason to believe that adaptive mechanisms of *Acer negundo* invasion will become more important with time, supporting the idea that a shift of invasion mechanisms from plastic responses in early phases towards genetic responses in later phases of invasion might apply.

Within-Species Differences in *Arrhenatherum elatius* Response to Extreme Weather Events

Carl Beierkuhnlein (1), Julia Gommola (2), Juergen Kreyling (1) Anke Jentsch (2)
(1) Biogeography, University of Bayreuth, D-95440 Bayreuth, Germany
(2) Disturbance Ecology and Vegetation Dynamics, UFZ - Helmholtz Centre for Environmental Research, Permoserstr.15, D-04318 Leipzig, and University of Bayreuth, D-95440 Bayreuth, Germany

Genetic and ecological variability within species can result in diverging responses to environmental change. Climatic change is expected to be accompanied by an increase in extreme weather conditions. Especially when key species for the maintenance of ecosystem functions are addressed, more knowledge for within species ecologic variability is urgently needed. Here, we focus on the widespread grassland species *Arrhenatherum elatius*. Within an experimental setting, 46 different European provenances are investigated according to their response to extreme weather events.

The experiment was designed to simulate occurrences of extreme drought and heavy rainfall, and provided a projection of 100-year extremes, based on local climate data acquired between 1961 and 2000. Drought was induced for a period of 32 days by rain-out shelters and heavy rainfall of 170 mm over 14 days by portable irrigation systems. The control corresponded to the ambient weather conditions. We comprised five replications of each treatment. Plant performance, biometric measurements and phenology (e.g. flower onset) were analysed. Results from ANOVA and TukeyHSD post-hoc comparison exhibited significant differences between the type of manipulation and the variety of provenances. ANPP differed significantly between heavy rain and drought. A lower ANPP was recorded under heavy rainfall, while drought resulted in overcompensation. The biometric measurements presented polymorphisms in phenotypes. Generally, flower onset was earlier under drought, while heavy rain did not influence flower onset significantly.

Evolutionary patterns of diversification in plant functional traits

Olivier Flores & Eric Garnier
C.N.R.S., Centre d'Ecologie Fonctionnelle et Evolutive (U.M.R. 5175)
1919, Route de Mende, 34293 Montpellier Cedex 5, France

Functional traits are phenotypic characters indirectly related to plant fitness and thus subject to natural selection [1]. They are widely integrated in a consistent ecological framework adressing processes from individual performance to ecosystem functioning. In this work, we performed a phylogenetic comparative analysis of two key functional traits implied in resource-use strategies [2]. Namely, leaf dry matter content (LDMC) relates to nutrient conservation, while specific leaf area (SLA, the light-intercepting area of a leaf per unit dry mass) relates to net assimilation and relative growth rates. Low LDMC and high SLA occur in fast-growing plants with rapid nutrient acquisition strategy, while slow-growing, nutrient-conservative plants show opposite trends.

Using informatic tools, we gathered detailed information about trait distributions and phylogenetic relatedness across numerous taxa of extant vascular plants. Standardized measurement records of SLA and LDMC were obtained from a locally built database (PlanTraits) as well as publicly accessible databases (GloPNet, LEDA) and literature. Further information regarding life-form (Raunkiaer's classification), growth-form, and life-history was extracted from online and paper floras and added for each species. Finally, trait values (attributes) were available for about 4600 species for SLA, and 2500 species for LDMC.

Because of phylogenetic kinship, species cannot be treated as independent statistical units. The current distribution of attributes across species results from both recent adaptation to the environment and species evolutionary history. As an hypothesis for phylogenetic kinship, we build a super-tree spanning the set of studied taxa. Namely, we binded together phylogenetic trees of the three major vascular plant clades (Ferns and their allies, Gywnosperms and Angiosperms) as a skeleton for the super-tree. Published phylogenies were included to enhance intra-family resolution at genus level. Genera within other non-resolved families as well as species within genera were binded as polytomies. Using Phylogenetic Comparative Methods (PCM), we characterized univariate as well as bivariate evolutionnary patterns among study taxa. For each trait, the current variability could be decomposed along the super-tree. We calculated the width of evolutionary divergences (nodes) as well as their contribution to the present-day variability.

Major divergences and highly diversified clades could be identified considering each trait separately. Phylogenetic conservatism influenced species attributes in both trait, althought at different levels. Shifts and diversification in resource-use strategy could be identified and related to function evolution among vascular plants. Our results confirm that the study of evolutionary patterns through PCM can help to refine knowledge of current ecological patterns.

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Poster presentations

Revealing genetic diversity and phylogeographic pattern of an inquiline gall wasp

Péter Bihari (1), Kálmán Somogyi (1), George Melika (3), Zsolt Pénzes (1,2), Graham N. Stone (4)
(1) Biological Resesarch Center of Hungarian Academy of Sciences, Institute of Genetics, Temesvári boulevard 62, H-6726 Szeged; Hungary
(2) Department of Ecology, Szeged University, H-6722 Szeged, Hungar
(3) Systematic Parasitoid Laboratory, Plant Protection and Soil Conservation Service of County Vas, Ambrozy setany 2, Tanakajd, 9762, Hungary
(4) Institute of Cell, Animal and Population Biology, University of Edinburgh, Ashworth Laboratories, The King's Buildings, West Mains Road, Edinburgh EH9 3JT, UK

Gallwasps (Hymenoptera: Cynipidae) induce a wide diversity of highly complex galls on a variety of host plants. However, around 12 % of known species have lost their ability to induce galls (Synergini), and develop as inquilines inside galls of other cynipids. *Synergus umbraculus* is the representative of the latter group and has been reared from oak galls of more than 30 gall wasp hosts.

In contrast to the gall inducers, we know little about inquilines. Species identification is difficult, resulting ambiguities in the taxonomy of *Synergus* genus. We examined (i) the genetic diversity within the species; (ii) the degree of genetic differentiation within and between populations, considering the possible effects of their hosts; and (iii) the large-scale phylogeographic pattern in Western Palearctic.

Based on sequences of three different mitochondrial and nuclear loci of 250 individuals remarkable degree of genetic differentiation was detected. Considering the orthologue sequences of other *Synergus* species, *Synergus umbraculus* can not be regarded as one uniform species since at least four cryptic species was found. Further analysis suggested that *S. umbraculus* does not depend on a particular host association. In the Carpathian Basin the effect of each sampled glacial refugium was observed.

Evolutionary Population History of the Leaf Beetle *Leptinotarsa undecimlineata* (Stål) (Coleoptera: Chrysomelidae)

Astrid Eben (1) & Alejandro Espinosa de los Monteros (2)
(1) Departamento de Ecología Funciona, Instituto de Ecología, A.C., km 2.5 carretera antigua a Coatepec, Xalapa 91070 Veracruz, México
(2) Departamento de Biología Evolutiva, Instituto de Ecología, A.C., km 2.5 carretera antigua a Coatepec, Xalapa 91070 Veracruz, México

In spite of its wide distribution (i.e., México to Colombia) and close phylogenetic relationships to important economic pests (i.e, *L. decemlineata*), the leaf beetle *Leptinotarsa undecimlineata* has been barely studied. This beetle is found in open areas, where it forms isolated colonies that are maintained in the same spot year after year. In Veracruz (México), this species has two generations per year, and completes its life cycle only on *Solanum lanceolatum* [1]. Life-history traits like these should be consistent with highly genetically structured populations with minimal gene flow between them. The current study uses a combined methodological approach including phylogenetic, phylogeographic, and population genetic analyses. These analyses are based on cytochrome oxidase I sequences (500 bp) from individuals collected in populations located throughout the species range in México. Our results revealed unexpected aspects of its population history.

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Mate finding by sexual pheromones in dytiscid water beetles

Christine Herbst (1), Beate Baier (2), Till Tolasch (3), Johannes L.M. Steidle (3)
(1) Lehrstuhl für Zoologie III, Tierökologie und Tropenbiologie, Am Hubland, 97074 Würzburg, Germany
(2) Institut für Hygiene und Umwelt, Marckmannstr. 129b, 21033Hamburg, Germany
(3) Universität Hohenheim, Fg. Tierökologie 220c, Garbenstr. 30, 70593 Stuttgart, Germany

Pheromones are signals that are used by a wide variety of species for intraspecific communication [1]. This is especially true for beetles, where sexual pheromones play an important role for mate finding and mating in terrestrial systems. In contrast, much less is known about sex pheromone communication of beetles in aquatic systems.

Therefore the present study was initiated to improve the knowledge on mate finding by sexual pheromones in dytiscid water beetles. Using three different experimental setups we tested the use of visual and chemical signals for mate finding by *Rhantus punctatus* (Steph.). In experiments with transparent Erlenmeyer flasks, which did not allow the diffusion of chemical signals, males and females were not attractive to the test beetles. In choice tests with opaque but water permeable vessels, male beetles were significantly attracted to females. Highest attraction of males to females was achieved in experiments with tea strainers which allowed the perception of a combination of chemical and optical cues.

These results demonstrate that *R. punctatus* females release sexual pheromones to attract mating partners and represent the first experimental proof of sexual pheromones in the beetle family Dytiscidae and the whole suborder Adephaga.

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Responses of life history traits to climate change depend on spatial and temporal scale

Marie Hermant (1), Andreas Prinzing (1), Richard Bailey (2) & Françoise Hennion (1)
(1) University of Rennes 1, UMR CNRS 6553 Ecobio, Av. du Général Leclerc, 35042 Rennes, France
(2) Uppsala University, Dept of Animal Ecology, Evolutionary Biology Centre, Norbyvägen 18 D, SE-752 36 Uppsala, Sweden

The costs and benefits of reproductive strategies are altered by a sudden climate change. To adjust to the new conditions, species would have to modify particular characters. Do plants indeed show such responses to environmental changes? Do they respond through a change in mean values of traits or through a change in trade-off between traits? At which spatial and temporal scales do these responses occur and are responses consistent across scales? We study the reproduction of the Kerguelen Cabbage (*Pringlea antiscorbutica*). This perennial plant is endemic in the Southern Indian Ocean around Kerguelen Islands, which currently undergo one of the fastest climatic changes in the world. We found that populations occupying different positions along large-scale climatic gradients tend to differ in plant size and seed weight and shape. This suggests a biological adaptation to different climatic environments. Across small spatial and temporal scales, in contrast, the plants show reinforcements in the trade-off between seed weight and seed numbers at high altitude as well as during warm and dry periods. This indicates a higher flexibility in reproductive strategies under stress conditions. In conclusion, the Kerguelen Cabbage can modify some characters to adjust reproductive strategy to environmental change. These responses depend on the spatial and temporal scale, with a change in mean trait values at large scale and a change in trade-off between traits at local scale.

Evidence for ecological speciation in the narrow endemic grass *Deschampsia wibeliana*

F.Heydel, B.Rudolph, K.Jensen
University of Hamburg, Biozentrum Klein Flottbek und Botanischer Garten, Ohnhorststr. 18, 22609 Hamburg, Germany

Deschampsia wibeliana (Sond.) Parl. is an endemic species growing in tidal freshwater and brackish habitats of the lower Elbe estuary. It is a member of the *Deschampsia cespitosa* complex, in which the phylogenetic relationships are not completely resolved so far. *Deschampsia cespitosa* (L.) P. Beauv. s. str. is a holarctic circumpolar distributed species and is found in moist habitats. In the past its natural habitat had strongly been affected by the impact of pleistocenic glaciation. The adaptation of *D. wibeliana* to tidal flooding might be the result of natural divergent selection on ecological traits followed by a reproductive isolation to populations of *D. cespitosa* as putative ancestor.

In the present study populations of both species located along a transect at the Elbe estuary were analysed genetically using molecular markers in order to compare the genetic structure of the two species. In addition controlled reciprocal ecological experiments were carried out, in which the response of *D. cespitosa* and *D. wibeliana* to tidal and non-tidal habitats was examined.

With respect to ITS sequences no variation was found between the congeners. However, AFLP analysis of 150 individuals (two primer combinations) showed a clear genetic differentiation between five populations of *D. cespitosa* and five populations of *D. wibeliana*. *D. cespitosa* showed a higher genetic variability as *D. wibeliana* while *D. wibeliana* showed a higher correlation of geographic and genetic distances than *D. cespitosa* indicating that geneflow is lower in the endemic taxon.

Measurements of biomass production and leaf morphometrics showed an ecological differentiation of both species according to the hydrological regime. *D. wibeliana* exhibited longer leaves than *D. cespitosa* indicating that leaf elongation might play a role in ensuring oxygen supply during tidal flooding. Furthermore the leave shape of *D. wibeliana* was significantly different from that of *D. cespitosa* what indicates that *D. wibeliana* might possess an adaptation to mechanical forces (e.g. wave action) in the Elbe estuary. In steady water saturation (no tidal flooding) *D. cespitosa* produced about twice as much biomass as *D. wibeliana*. In longtime tidal flooding *D. wibeliana* exhibited about 70 % more biomass than *D. cespitosa*.

Furthermore a reproductive isolation through a divergence in flowering time in the two species is strongly indicated.

In this project molecular and ecological methods were combined to contribute to the investigation of ecological speciation in *D. wibeliana*. In prospective studies further endemic taxa from the *D. cespitosa*-complex will be included.

Changing hiding patterns in fennel pondweed tubers in response to predation by Bewick's swans

Bert Hidding
NIOO-KNAW, centre for limnology, Nieuwersluis, the Netherlands

Deep burial in the sediment of tubers of fennel pondweed (*Potamogeton pectinatus*) in the shallow lake Lauwersmeer has been explained in terms of avoidance by escape against intense episodic predation by migratory Bewick‘s swans (*Cygnus columbianus bewickii*) in autumn. We expected changes in predation pressure to ultimately result in a change of the tuber distribution across sediment depth. A trade-off underlies this idea. Deep tubers are less accessible to swans but they must be larger to meet the higher energy demands of sprouting. We compared tuber burial depth over a gradient of predation pressure both across space and across time. First, we compared the current tuber bank in the Lauwersmeer with that in two wetlands with moderate and low predation pressure. Second, we compared present tuber burial with that in the early 1980s within the Lauwersmeer, when exploitation by swans had just started. We found deeper burial of tubers under moderate to high predation compared to low predation. Additionally, in a four-year exclosure study in the lake Lauwersmeer, we excluded Bewick ‘s swan grazing by protecting plots with mesh wire attached to the sediment during autumn and winter. Indeed, in protected plots mean burial depth of tubers in the sediment was shallower than in control plots after four years. These observations suggest an adaptive response of fennel pondweed to foraging by Bewick’s swans, where both phenotypic plasticity and genotype sorting may contribute to the differences in tuber depth.

Seed quality determines dispersal services by ants

Christine Becker, Hans Joachim Poethke, Kerstin Reifenrath
Ecological Fieldstation Fabrikschleichach, University of Wuerzburg, Department of Animal Ecology, Glashuettenstr. 5, 96181 Rauhenebrach, Germany;

Mymecochores spring flowering herbs are typically characterised by seeds bearing elaisomes. The chemical and structural characteristics of such seeds determine the ants' dispersal behaviour.

Cafeteria field experiments were performed in order to quantify the dispersal rate of two ant species for seeds of three plant species with and without elaiosome. We found that not all elaiosome bearing seeds are equally well adapted to ant dispersal. Transport rates of *Myrmica ruginodes* for *Viola odorata* and *Hepatica nobilis* were similar, whereas *Lasius fuliginosus* prefer *V.odorata* over *H. nobilis*. Both, elaiosomes and seeds of *Pseudofumaria lutea* were rejected by both ant species. In conclusion, the observed preferences of ants for elaiosomes and seeds may indicate at least a weak degree of specialisation. Differences in their nutritional quality may differently meet the ants' metabolically requirements

Species crossability and hybrid performance of riparian willows

Eike Neuschulz, Eva Mosner, Ilona Leyer
Philipps-University of Marburg, Faculty of Biology, Conservation Biology Group, Karl-von-Frisch-Str. 8, 35043 Marburg, Germany

Hybridisation frequently occurs within the genus *Salix*. However, the extent of hybridisation affecting floodplain willow communities is fairly unknown. Species crossability relationships of the willows *Salix viminalis* and *Salix fragilis* were investigated in artificial pollination experiments. Seed production and germination strongly depended on the crossing combination. Interestingly, parental sex arrangements in hybrid crossings were evident. Seedling fitness of *S. viminalis x fragilis* was significantly higher than the fitness of *S. fragilis x viminalis* seedlings.

To assess and compare pure species and hybrid seedlings' performance, seeds of the crossings *S. fragilis x fragilis*, *S. viminalis* x *fragilis* and *S. viminalis x viminalis* were sown on two soil types (pH 5 and 6.7) and exposed to two water treatments (moist and waterlogged).

There were no significant effects of soil treatments on the establishment of *S. viminalis x fragilis* seedlings. In contrast to the species-specific soil preferences of *S. fragilis* and *S. viminalis*, seedlings of both pure species crossings established better on soils of pH 6.7. Waterlogged conditions strongly reduced establishment of all crossings. In contrast, plant height was higher than under moist conditions. This might rather be a result of an "escape" from unsuitable conditions than reflecting better growing conditions.

Comparing hybrid to pure species performance, hybrid establishment was strongly reduced due to high seedling mortality. However, hybrids outperformed their parent individuals in height and dry mass. Hence, hybrid occurrence in willow populations is supposed to be rare because of scarce hybrid establishment itself. But once establishment succeeded, hybrids may persist in willow communities over time.

Lack of phenotypic plasticity may limit the rare herb *Inula hirta*

Jana Raabová (1,2) & Zuzana Münzbergová (2,3)
(1) Department of Botany, National Museum, Czech Republic
(2) Department of Botany, Faculty of Science, Charles University, Czech Republic,
(3) Institute of Botany, Academy of Sciences of the Czech Republic, Czech Republic

As a result of human activities, many plant species became rare and are threatened with extinction. To reveal factors possibly limiting rare species, studies comparing ecological traits between pairs of rare and common closely related species are commonly done. However, to determine the ability of species to spread into new areas and survive there, the plasticity of traits is often more important than their mean values. Nevertheless, little attention has been paid to the plasticity of traits in studies comparing rare and common species. The present study aimed to compare phenotypic plasticity between two perennial herbs of the *Inula* genus that share the same habitats but differ in their abundance, rare *I. hirta* and common *I. salicina*. We used plants from two different populations per species and grew them in the substrates from the two sites in the experimental garden for two years. The common species *I. salicina* had higher number of stems, plant height, above- and belowground biomass, and number of flower heads than *I. hirta*, whereas the rare I. hirta had higher flowering percentage. Slopes of reaction norms were steeper in the common I. salicina than *in I. hirta* for number of stems, above- and belowground biomass and flowering percentage, but not for survival percentage. The results indicate higher plasticity of the common species. Smaller phenotypic plasticity may therefore limit the rare herb *I. hirta* compared to the common *I. salicina*.

Seed dispersal and predation? The role of ants and antagonists

Henrik Köhler, Hans Joachim Poethke, Kerstin Reifenrath
Ecological Fieldstation Fabrikschleichach, University of Wuerzburg, Department of Animal Ecology, Glashuettenstr. 5, 96181 Rauhenebrach, Germany;
**reifenrath@biozentrum.uni-wuerzburg.de*

The dispersal success of plants depend on the activity, identity and feeding preferences of dispersal agents as well as antagonists. Ants are important dispersal agents for elaiosome-bearing seeds in deciduous forests. Moreover, seeds attract various other small animals: different arthopods, snails and small rodents, who can also strongly affect the seed fate and are largely considered seed predators rather than dispersal agents. For both, ants and antagonists, transport and consumption rates differ across plant species and are determined by the structure and the presence of elaiosomes.

We performed multiple choice cafeteria experiments in the field. Ants were excluded from artificial seed depots in order to test the impact of dispersing ants and predating antagonists on the fate of seeds. Removal rates of ants and seed feeders were determined in order to quantify fundamental and realised preferences for seeds. Preferences were related to structural features and chemical quality of seeds.

What does taste better- native or exotic, or both? Dietary specialisation of the Australian Golden Sun Moth (*Synemon plana*, Castniidae)

Anett Richter (1), Michael Traugott (2), Corinna Wallinger (2), Mark Dunford (3) & Will Osborne (1)
(1) Institute for Applied Ecology, University of Canberra, ACT 2601, Australia
(2) Institute of Ecology, University of Innsbruck, Techniker Strasse 13, Innsbruck 2060, Austria
(3) Geoscience Australia

The Golden Sun Moth (*Synemon plana*) is an Australian day-flying moth, listed nationally as a critically endangered species that is believed to be a declining due to the loss and degradation of its natural habitat - Lowland Native Grasslands, also a nationally endangered vegetation community. A major threat to native grassland is the invasion of exotic species such as Chilean Needle Grass (*Nassella neesiana*), a weed of national significance that has been introduced to Australia from South America. Although never tested, based on observations it has been assumed that *S. plana* larvae feed exclusively on *Austrodanthonia*- native Wallaby Grass species. However, recent observations of high abundances of *S.plana* adults in areas dominated by *N. neesiana* have lead to the provocative hypothesis that the larvae are not a native grass specialist.

This proposed study will (a) identify the diet of *S.plana* larvae by applying the molecular techniques of multiplex Polymerase Chain Reactions (PCR) and (b) explore the evolutionary relationship between food webs and adaptational behaviour in an Australian endangered moth species.

The results will improve our understanding of Australia's invertebrate biodiversity and will advance our ability how to manage native grasslands and invertebrate species in future. Most importantly, the project provides the opportunity to gain insight into the evolution of trophic interactions within the concept of species invasion and the origin of species.

Fungi as 'hidden players' in a model host-parasitoid interaction

Marko Rohlfs
University of Kiel, Zoological Institute; Am Botanischen Garten 1-9, 24098 Kiel, Germany

So-called 'hidden' organisms, such as filamentous fungi, have been demonstrated to have a huge impact on the structure and diversity of insect communities. The underlying mechanisms, however, and the evolutionary implications of insect-fungus interactions on both groups of organisms are poorly understood. Filamentous fungi have recently been shown to be engaged in strong competition with saprophagous insects, such as *Drosophila* larvae [1]. We tested whether such fungi change interaction patters between *Drosophila melanogaster* and its parasitoid *Asobara tabida*, on the level of immature host/parasitoid development and on the level of parasitoid behaviour; moreover, we looked at the possible effects of host-parasitoid interaction on fungal fitness [2]. 1) Compared with healthy larvae, parasitised hosts suffered from higher mortality rates in the presence of fungi, though larval aggregation had a positive effect on host survival (Allee effect). 2) Despite this beneficial effect of host aggregations in a mouldy environment, *Asobara* wasps did not search as long for hosts as their did on mould-free substrates, suggesting that there is a fungal-borne refuge against parasitic wasps. 3) Parasitised fly larvae reduced fungal fitness to a less significant extent than did healthy larvae, which seriously hampered fungal growth. This observation indicates alterations in the dominance relationship between insects and fungi and hence provides first evidence of parasite-mediated competition between these distantly related taxa.

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Assessing Patterns of Species Diversity on the Canarian Island Archipelago

Manuel Steinbauer (1), Carl Beierkuhnlein (1), José-Marie Fernández-Palacios (2)
(1) Lehrstuhl Biogeographie, Universität Bayreuth
(2) Universidad de La Laguna, Tenerife

The Canary Islands are a place of pilgrimage for ecologists since the time of Alexander von Humboldt and Charles Darwin. Even if there is still some debate on the taxonomic status of some endemic species, there exists an excellent quality of biotic data that can be used for biogeographical analyses. In this study we analyse island specific data for the following groups: Spermatophyta, Pteridophyta, Bryophyta, Lichenes, Fungi, Chordata, Arthropoda, Mollusca.

Species diversity on islands depends on evolutionary processes, migration and dispersal abilities. The species pool on Continental Africa, however, is not constant. Today only few habitats on the continent can host comparable communities for Canarian ecosystems. The special situation that the source species pool of the African continent became quantitatively extinct due to climate change during the Holocene, is a remarkable fact that distinguishes the situation from many other island floras and faunas.

Interdependencies between species richness and endemism are under debate. Large species pools may on the one hand increase competitive exclusion and predation and therefore increase the risk of extinction for a single species. On the other hand species are forced to react to ecological pressure by adaptation. As a result large species pools might offer more options for evolutionary processes and speciation or in other words: species diversity drives speciation. However, correlations found are not necessarily reflecting general functional processes. With our data set we are able to tackle evolutionary theories and deepen the discussion specifically for groups of organisms with varying mobility and turn-over.

In addition, the Canary Islands offer a wonderful experiment to prove the theory of island biogeography and to extend this theory to variables such as habitat heterogeneity and functional connectivity. Besides the alpha-diversity and species pool of separate islands and the total species pools for the considered groups of organisms, we address also beta-diversity relationships between islands. Here we identify also considerable differences in the similarity patterns between organismic groups.

Foreign-language skills in beetles? Chemical mimicry of ant alarm pheromone in *Pella* beetles (Staphylinidae)

Michael Stöffler (1), Tanja Maier (2), Johannes L.M. Steidle (1)
(1) Universität Hohenheim, Fg. Tierökologie 220c, Garbenstr. 30, 70593 Stuttgart, Germany
(2) Universität Bielefeld, Abt. f. Chemische Ökologie, Universitätsstraße 25, 33615 Bielefeld, Germany

Pella beetles are myrmecophilous beetles living in the surroundings of *Lasius fuliginosus* colonies [1]. Using chemical analyses as well as behavioural tests in the laboratory and in the field, we tested the hypothesis that *Pella* beetles mimic alarm pheromone compounds of their host ant *L. fuliginosus* to avert attacks. The secretion of *P. funesta* and *P. humeralis* contains quinones and different aliphatic compounds, mainly undecane and 6-methyl-5-hepten-2-one (sulcatone) [2]. Both substances can also be found in *L. fuliginosus* pheromone glands [3].

Behavioural tests confirmed that undecane serves as an "aggressive alarm" stimulating pheromone in *L. fuliginosus*, whereas sulcatone most likely represents a "panic-alarm" inducing pheromone. In laboratory as well as in field experiments, the main tergal secretion compounds quinones and undecane as well as their mixtures caused aggressions in workers of *L. fuliginosus*. When sulcatone was added to these compounds and mixtures, the odour source surrounding space was avoided and a reduced number of aggressive acts was observed. Obviously, sulcatone overrules the aggression-inducing effect of undecane and quinines [4].

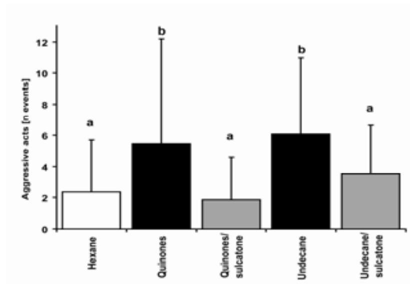

Figure 1: Aggressive acts of ants (mean ± SD) towards a filter paper ball treated with different chemicals present in the beetles tergal secretion. Bars with different letters are

These results support the hypothesis that *Pella* beetles mimic an alarm pheromone of their host. In contrast to many publications, that centre on the mimicry of cuticular hydrocarbons, our study represents a rare - if not the only – reported case of chemical mimicry in myrmecophilous insects where other pheromonal cues are used.

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[3] Bernardi R, Cardani C, Ghiringhelli D, Selva A, Baggini A, Pavan M (1967) Tetrahedron Letters, 40, 3893-3896.
[4] Stöffler M, Maier T, Tolasch T, Steidle JLM (2007) Foreign-language skills in rove-beetles? Evidence for chemical mimicry of ant alarm pheromones in myrmecophilous *Pella* beetles (Coleoptera: Staphylinidae). Journal of Chemical Ecology, 33, 1382-1392.

Evolutionary consequences of habitat fragmentation: pollinator-mediated selection on plant phenotypic traits

Anne Weber & Annette Kolb
Vegetation Ecology and Conservation Biology, Department of Ecology and Evolutionary Biology, University of Bremen, Leobener Str., D – 28359 Bremen, Germany.

Habitat fragmentation may affect plant-pollinator interactions, and pollinators are known to act as selective agents on plant phenotypic traits such as plant size, flowering phenology and floral display. However, only little is known about how fragmentation influences patterns of selection on plant phenotypic traits via changes in pollinator availability, and there is also only very little knowledge about the degree to which plants in fragmented populations are able to respond to such natural selection pressures. The two major aims of this recently begun project are therefore to investigate habitat fragmentation effects 1) on pollinator-mediated selection on plant phenotypic traits in a self-incompatible, perennial herb (Phyteuma spicatum, Campanulaceae), and 2) on the potential to respond to such selection via effects on the amount of heritable variation in relevant traits. First population-level results show that plants in small populations receive fewer pollinator visits than plants in large populations and that populations with taller and thus more apparent plants are more attractive to pollinators than populations with smaller plants, but only when populations are small. By investigating evolutionary consequences of habitat fragmentation, the results of our project will contribute to a more in-depth understanding of how human-induced environmental change may affect plant evolutionary trajectories in present-day landscapes.

Changes of biodiversity in time and space: Connecting genetics, evolution, and processes

5.3. Long term and large scale impact of GMO in agriculture

Hartmut Meyer, Wolfgang Büchs

Oral presentations

Modeling *Bt* protein degradation patterns in the field with a first-order decay approach

Corinne Zurbrügg & Wolfgang Nentwig
University of Bern, Zoological Institute, Baltzerstrasse 6, 3012 Bern, Switzerland

The release of transgenic *Bacillus thuringiensis* (*Bt*) maize expressing various Cry endotoxins has raised concern that the latter may have direct and indirect effects on the soil ecosystem since *Bt* proteins can persist for a relatively long time in soil. Nevertheless, field and laboratory studies assessing *Bt* protein persistence in soil found contradictory results. We therefore quantified degradation of two *Bt* proteins (Cry1Ab, Cry3Bb1) in maize leaves at four different soil temperatures and at two soil moistures in standardized microcosms. With the obtained data, *Bt* protein degradation from harvest to the next planting season was simulated (estimated *Bt* protein degradation) and compared to *Bt* protein degradation rates measured in the field (measured *Bt* protein degradation) with a first-order decay model. The Cry3Bb1 protein was degraded faster than the Cry1Ab protein at all four temperatures at both soil moistures. Moreover, *Bt* protein degradation increased with increasing temperature for both *Bt* proteins. Estimated *Bt* protein degradation rates fitted rather well with the effectively measured *Bt* protein concentrations in decaying leaf litter in the field, whereas estimated *Bt* protein degradation was in most cases faster than *Bt* protein degradation measured in the field. However, estimated *Bt* protein degradation rates seemed to be less appropriate to describe degradation at low soil temperatures and frozen soil, particularly for the Cry1Ab protein.

Crop litter decomposition in Roundup Ready® and conventional cropping systems

Jeff R. (1,2), David J. Levy-Booth (3), Robert H. Gulden (4), Wendy L. Asbil (5), Rachel G. Campbell (4), Kari E. Dunfield (3), Allan S. Hamill (6), Miranda M. Hart (1), Sylvain Lerat (7), Robert E. Nurse (6), K. Peter Pauls (4), Peter H. Sikkema (8), Clarence J. Swanton (4), Jack T. Trevors (7) & John N. Klironomos (1)
(1) Department of Integrative Biology, University of Guelph, Guelph, ON, Canada
(2) Freie Universitaet Berlin, Institut fuer Biologie, Altensteinstr. 6, 14195 Berlin, Germany
(3) Department of Land Resource Science, University of Guelph, Guelph, ON, Canada
(4) Department of Plant Agriculture, University of Guelph, Guelph, ON, Canada
(5) Kemptville Campus, University of Guelph, Kemptville, ON, Canada
(6) Agriculture and Agri-Food Canada, Greenhouse and Processing Crops Research Centre, Harrow, ON, Canada
(7) Department of Environmental Biology, University of Guelph, Guelph, ON, Canada
(8) Ridgetown Campus, University of Guelph, Ridgetown, ON, Canada

Genetically-modified, herbicide-tolerant crops have been extensively adopted in North America and other parts of the globe [1,2]. Most commercially available varieties are tolerant of the herbicide glyphosate, giving rise to the dominant market penetration of Roundup Ready® cropping systems [3]. This study describes a series of microcosm and field experiments in southern and eastern Ontario, Canada, that estimated the effects of transgenic, glyphosate-tolerant (GT) crops and their management on crop litter decomposition. Litter mass remaining in mesh bags was estimated under varying climatic and edaphic conditions and under conventional and no-tillage systems. We estimated effects associated with the genetic modification itself, as well as with the associated herbicide management system. We observed little effect of the modification for glyphosate-tolerance on maize (in the field) and soya (in microcosms) litter decomposition. Overall, herbicide management associated with GT crops reduced soya- and maize-litter decomposition in the field. However, responses to GT herbicide management were inconsistent across Ontario, with many trials demonstrating no effect. Average daily precipitation was positively correlated with the magnitude of GT effect; no effect was observed for trials receiving, on average, less than 2.5 mm precipitation per day for the duration of litterbag decomposition, while reductions in litter decomposition were associated with GT herbicide management for half of the trials above 2.5 mm d^{-1}. These data suggest that litter decomposition in GT cropping systems is more likely to be affected by herbicide management practices than by litter characteristics associated with the genetic modification, but that the manifestation of effects are significantly dependant on environmental factors.

[1] James, 2006, Brief 35-2006 (Executive Summary), ISAAA, Ithaca, NY
[2] NASS, 2006, Acreage. US Department of Agriculture, Washington, DC
[3] Duke, 2005, Pest Manag Science 61: 211-218

Performance of decomposers and predators under the influence of Diabrotica-resistant Bt-maize (Cry3Bb1) and conventional cultivars

Wolfgang Büchs, Oliver Schlein, Sabine Prescher
JKI, Institute for Plant Protection in Field Crops and Grassland, Braunschweig, Germany

One of the most serious pests of maize in the USA, the Western Corn Root Worm (*Diabrotica v. virgifera*) first time occurred in Germany in August 2007. In a 3-years-study 4 different maize cultivars including *Diabrotica*-resistant MON88017 (Bt-toxin Cry3Bb1), were assessed in respect to its effects on saprophagous Diptera and their coleopteran predators (Coleoptera: Carabidae et Staphylinidae) in field and lab experiments. The methodological approaches comprised a hierarchic order of different ecological scale levels (agro-ecosystem, population, organism). Abundance and species composition of both Diptera and their predators were recorded in the field. The majority of saprophagous Diptera belong to the fungus gnats (Nematocera: Sciaridae), ca. 20% of them to the predominant *Lycoriella castanescens* which was mass-reared for feeding trials with plants parts of Bt- and non-Bt-maize-cultivars. It was tested whether mortality, pupation, hatching rates, the duration of larval development and pupation were affected by uptake of CryBb1-contminated plant tissues. For predator species in Bt- and non-Bt-maize plots the endogaeic activity of their larvae was recorded as well as the hatching rate of the new generation as measure for reproduction success. Species of Carabidae and Staphylinidae were fed with Sciaridae-larvae reared on Bt- and non-Bt-maize-litter respectively. In other trials in a similar way *Diabrotica*-larvae were offered as prey. Analysis of toxin contents of saprophagous Diptera and predators reared with Bt-plant parts or feeding on Bt-toxin-contaminated prey showed that both functional groups contain Bt-toxin up to 1,6% of the toxin level which was recorded in the source material. Analysis of predators collected from Bt-maize fields stated these findings. Thus, Bt-toxin is transferred into the food chain. Predators feeding on prey containing Cry3Bb1-toxin showed a significant delay in accepting the prey in comparison to prey free of Bt-toxin, but this didn't result in higher mortality or less longevity. However, those predators which exclusively were fed with Sciaridae-larvae containing Bt-toxin produced significantly less offspring than those feeding on larvae of saprophagous Diptera which were reared with non-Bt-maize litter. Thus, it can be assumed that a continuous uptake of Cry3Bb1-toxin by carnivorous beetles doesn't lead to a higher mortality, but results in subtle effects like lower fertility of the females.

The results are discussed in respect to the question how (subtle) effects on the fitness of populations of species inhabiting agro-ecosystems observed in specific studies can be included into monitoring procedures, how they can (or have to be) be transferred to higher scale levels and how it is possible to detect them reliably on these levels.

Implementation of Bt maize (MON810) monitoring of long-term environmental effects on national level: The German example

Detlef Bartsch, Hans-Jörg Buhk, Achim Gathmann, Christiane Koziolek & Anja Vaasen
Bundesamt für Verbraucherschutz und Lebensmittelsicherheit (BVL), Mauerstraße 39-42, 10117 Berlin

Placing on the EU market of a Genetically Modified Organism (GMO) requires a consent issued by the European Commission. Applicants are requested to submit a dossier including a post-market environmental monitoring (PMEM) plan according to basic conditions set in Directive 2001/18/EC. Detailed guidance is provided by the European Food Safety Authority [1]. The consent holder is responsible for the establishment of the PMEM plan, duly enforcement, presentation & analysis of data & results, how participation of third parties takes place, consideration of latest scientific knowledge & practice, and periodic reporting. One important task within the implementation of general surveillance plans is to link monitoring to environmental protection goals. Targets should be selected for 'what to protect' in line with national environmental protection goals. Other legal EU frameworks provide guidance, and in particular the Directive 2004/35/EC [2] puts emphases on three environmental compartments: biodiversity, water and land. 'Damage' to the environment is defined there as a measurable adverse change in a natural resource or measurable impairment of a natural resource service which may occur directly or indirectly. There are three practical benefits in Directive 2004/35/EC that merit attention for EU wide harmonization of general surveillance of GMO: (1) 'damage' means a measurable adverse change. This definition has implication for general surveillance in respect to practicality as there is a need to look for quantification of monitoring parameters. (2) The significance of any damage need to be evaluated on case-by case bases particularly in view of the population (size) of protected species. This definition has implication for the assessment of the effect and magnitude of observed changes. (3) member states are required to monitor the favourable condition of certain protected areas and other protection goals. This definition has implication for the availability and use of existing environmental surveillance (EES). However, the details of such PMEM plans need to be specified in view to their implementation on national Member State level. In this respect the German BVL guided the company Monsanto in the selection of appropriate EES systems and in developing systems which may provide useful data in Germany for Bt maize MON810 general surveillance. For example, BVL assessed whether EES systems monitor relevant protection goals, cover extended regions of Germany, and report publicly available information [3].

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[2] EC, 2004. Directive 2004/35/CE of the European Parliament and of the Council of 21 April 2004 on environmental liability with regard to the prevention and remedying of environmental damage. Official Journal of the European Communities L 143: 56-75.
[3] BVL 2008 Hintergrundinformation zur Beobachtung (Monitoring) des gentechnisch veränderten Mais MON810. Informationen zur Bedeutung der Umweltbeobachtung und zum Verfahrensablauf. http://www.bvl.bund.de/

Potential effects of Bt proteins from "stacked" maize to non-target lepidoptera in agrarian systems

Mechthild Schuppener (1), Sabine Eber (1), Ingolf Schuphan (2) & Stefan Rauschen (1)
(1) RWTH Aachen, Institute of Biology III (Plant Physiology) , Worringer Weg 1, 52074 Aachen, Germany
(2) RWTH Aachen, Institute of Biology V (Environmental Research), Worringer Weg 1, 52074 Aachen, Germany

The cultivation of transgenic maize expressing Lepidopteran-specific Bt proteins is an effective control measure against the European corn borer (*Ostinia nubilalis*). The proteins selectively affect Lepidopteran larvae and are expressed in all tissues of the maize plant, also in pollen. Pollen is dispersed by wind from maize fields onto other plants and is taken up by non-target Lepidoptera larvae while feeding on these plants. Several feeding studies have shown negative effects of Bt proteins on non-target Lepidoptera, but the results of these laboratory studies can not be transferred to the situation in the field, because the amounts of Bt protein or maize pollen applied are not realistic. Therefore it is important to quantitate the real deposition of pollen in the surroundings of maize fields.

The aim of our study is a comprehensive risk assessment for selected non-target butterflies in agrarian landscapes. The first step of the study is to choose appropriate species that comply with the following requirements: 1. Common in agrarian landscapes, 2. monophage diet for an exact inventory, 3. development of larvae during maize anthesis. The species Small Tortoiseshell (*Aglais urticae*) and Peacock (*Inachis io*) accord with these attributes. The populations of both species are collected during the time of pollination. The host plant Stinging nettle (*Urtica dioica*) and the nests of butterflies are mapped in the surroundings of maize fields in two different regions of Germany. The regions differ in view of maize cultivation and landscape structure – one region with a high and one with a low percentage of maize cultivation. The spatial data are visualized and analysed with a geographic information system (GIS – ArcView).

In the second step, we assess the actual dispersion of pollen by placing pollen traps around a maize field in different distances during anthesis. After a defined time of 8 hours the traps are replaced and the amount of pollen is quantitated. Parallel to this, leaves of *Urtica dioica* are collected in the same distances and adhering pollen is also counted.

In the third step, we perform feeding studies under laboratory conditions with the "stacked" maize line MON89034 x MON88017 which contains the compound protein Cry1A.105 and the protein Cry2Ab2, both directed against Lepidoptera. Larvae of *Aglais urticae* and *Inachis io* will be fed with *Stinging nettle* covered with different amounts of transgenic maize pollen, different Bt protein combinations and different Bt protein amounts. The larvae are inspected every day until pupation. Weight, growth and mortality are assessed. At different times the content of Bt protein in larvae is measured with Enzyme-Linked Immunosorbent Assay (ELISA).

With this we want to calculate the actual risk of non-target Lepidoptera against "stacked" Bt maize, particularly with regard to different landscapes and cultivation characters. First results will be presented.

Poster presentations

Does GM wheat affect Drosophila melanogaster?

Marco Peter, Andreas Lindfeld & Wolfgang Nentwig
University of Bern, Zoological Institute, Baltzerstrasse 6, 3012 Bern, Switzerland

Genetically modified (GM) plants might affect ecosystem functioning through possible changes of plant compounds such as C:N ratio or lignin content, caused by the insertion of a gene of novel proteins. These possible changes of plant compounds might alter food quality, which could affect the survival, fecundity and development time of soil organisms, which play an important role in decomposition of organic matter. Therefore an ecological risk assessment should be done prior to the wide scale use of a GM crop. In a laboratory feeding experiment, we investigate possible effects of transgenic wheat on the saprophagous diptera *Drosophila melanogaster*. We determine if important fitness parameters, such as fertility, development time and sex ratio differ when they are fed either with leaves of transgenic or non-transgenic wheat. Furthermore we investigate if fitness parameters also differ when *D. melanogaster* are fed with different non-transgenic varieties. Fitness parameters are measured over four generations. We use six transgenic and five non-transgenic wheat varieties. Four of the transgenic varieties express proteins with a specific antifungal activity and two have a broad antifungal activity (chitinase, glucanase). Our results should give information about the potential influence of transgenic wheat on soil-dwelling organisms.

Effects of Coleopteran-specific Bt maize expressing Cry3Bb1 on epigeal arthropods

Kai U. Priesnitz (1), Ullrich Benker (1) & Martina Roß-Nickoll (2)
(1) Bayerische Landesanstalt für Landwirtschaft, IPS 2d, Freising, Germany
(2) RWTH Aachen University, Institute of Environmental Research (Biology V), Aachen, Germany

Diabrotica virgifera virgifera will most probably become the new major pest in maize throughout Europe. For the control of this pest an alternative to insecticide application could be growing GM maize, like the event MON88017, expressing the coleopteran specific Bt-protein Cry3Bb1. But before any GM plant can be cultivated on a large scale, possible adverse effects must be excluded.

We assessed the impact of MON88017 on non-target organisms in a field release experiment. The study examined the abundance of activity, a relative density, of ground beetles (Carabidae) and spiders (Araneae) in four maize varieties including the genetically modified MON88017, the near-isogenic line and two conventional varieties, each planted in eight plots in a systematically randomised plot design. Carabidae and Araneae are important predators of the biocenosis in maize fields and could get into indirect or direct contact with the Bt-protein. During the growing period of maize pitfall traps were used to collect the ground dwelling arthropods, which were determined to species level. Statistical comparisons showed no significant differences of ground beetle densities between the four maize varieties. The abundance of activity of spiders has still to be statistically evaluated.

Additionally, the internal content of Bt-protein in ground beetles collected from the field was measured with DAS-ELISA. A qualitative test system from Agdia Inc. was modified to analyse quantitative amounts of Cry3Bb1 before and after pollination in carabids. Bt-protein was found within 69% of the ground beetles sampled in Bt-plots after pollination. The absolute values of Cry3Bb1 in these samples ranged from 0.36 ng/g to a maximum of 3.7 mg/g protein.

Biodiversity in genetically modified herbicide tolerant crops

Beate Strandberg & Marianne Bruus
University of Aarhus, National Environmental Research Institute, Dept. of Terrestrial Ecology, Denmark

Most GMO crops are characterized by being tolerant to herbicides. Several studies have documented that the herbicide usage associated with the crop may affect biodiversity. Our studies support this, but also show that the effect on biodiversity may be highly variable. In some genetically modified herbicide tolerant (GMHT) crops such as fodder beet the first spray may be postponed several weeks compared to conventional spraying. The delay results in a spray-free period and “a window for biodiversity”. If the spay-free period lasts 14 days or more significantly more weeds and higher arthropod densities are found in the field. In our studies a window of one month did not reduce fodder beet yield significantly, although weed densities were high at the time of spraying. However, if the farmer sprayed the GMHT crop early or only allowed a short delay it resulted in very low weed and arthropod densities. A ’green profile’ of farmers involves reduced herbicide dose, late herbicide spraying and avoidance of pre-emptive insecticide spraying. However, a recent sociological study performed in relation to the study described here has shown that the willingness of farmers to adapt their spraying habits is doubtful and requires specific incitement.

Changes of biodiversity in time and space: Connecting genetics, evolution, and processes

5.4. Palaeoecology: Biodiversity through time

Norbert Kühl, Frank Schlütz, Oliver Nelle, Hermann Behling

Oral presentations

Reconstruction of dynamic history of abiotic and biotic impacts on regional Angiosperm diversity

Igor Bartish & Andreas Prinzing
(1) Université de Rennes 1
Unité Mixte de Recherche CNRS 6553 « Ecobio » :Ecosystèmes - Biodiversité - Evolution
263 Avenue du Général Leclerc
35042 Rennes Cedex, France

Diversity gradients caused by direct impacts of the environment on evolutionary diversification have been invoked primarily at a biogeographic scale. Biodiversity, however, varies also at small scales between habitats within regions. We used data from The Netherlands on local community composition of high spatial resolution to test non-randomness of associations between environmental factors and diversification of Angiosperms within regional habitat species-pools. For each habitat type, taxonomic diversity was estimated as a generalized measure over the entire evolutionary history. Rates of diversification were estimated as average distances from the root of a super-tree, and as species/genus (genus/family, family/order, etc.) ratios. We found major differences between habitat types. We compared these results with seven different scenarios of diversity evolution in habitat types along environmental gradients, invoking differences in the ages of the habitat types and in the diversification rates within the habitat types. Significantly positive associations of temperature, nitrogen availability, and soil pH with taxonomic diversity were most compatible with a scenario of accumulation of diversity over time in old habitat types, but not with increased diversification rates. In contrast, diversification rates were significantly higher in habitats with low soil moisture than in habitats of high soil moisture, while low soil moisture did not correlate to higher taxonomic diversity. This is most likely a result of a dynamic history of the impact of moisture on diversification rates: in fact the relationship between moisture and diversification changed from strongly positive in the earliest diversification of Angiosperms to negative between diversification of families and genera, and again back to positive in the most recent diversification. We found grazing pressure to have a positive impact on both diversification rates and taxonomic diversity. This result is consistent with an interpretation of long-term accumulation of diversity in habitats experiencing grazing pressures. Finally, luminosity showed no significant relationship to taxonomic diversity or diversification. Altogether, our results reveal that the abiotic and biotic environment within different habitat types has driven the macroevolution of plant lineages, influencing today's diversity patterns within a region. The role of environmental factors was not constant throughout evolution, but highly dynamic. Different periods were dominated by different environmental factors and the same factor could affect diversification positively during one and negatively during another period of Angiosperm evolution. These findings lend support to some recent hypotheses, based on independent paleoecological and paleobotanical data. Although it remains uncertain, if the revealed patterns will hold in analyses of other floras, our approach may provide a useful tool to study macro-ecological evolutionary processes.

Charcoals from soil show Holocene vegetation dynamics - pedoanthracology as a contribution to integrated ecosystem research

Vincent Robin & Oliver Nelle
Christian-Albrechts-University of Kiel, Ecology Centre, Department of Geobotany, Olshausenstr. 75, 24118 KIEL, Germany

Today work on biodiversity conservation should base on an interdisciplinary or / and multidisciplinary approach, which takes into account that one ecological entity is not isolated and fixed, but a complex, dynamic, and global system. Indeed, the current state of an ecological system is the result of ecological mutual interactions, i.e. processes at different levels of ecological systems and along different timescales. For this reason, interdisciplinary or / and multidisciplinary approaches are the best scientific approaches to study ecological systems because they allow to take care of time and space of the dynamic ecological processes. Furthermore, one main dynamic driver of ecological systems is disturbance. This process allows a perpetual space and time resumption of vegetation dynamics, based on their occurring regime. Thus, it is very important to consider this aspect of ecological system dynamics.

Pedoanthracology is one palaeoecological discipline based on extraction and species identification of charcoal pieces from soil where they are burried and kept during millenniums. It provides data which have a very fine spatial resolution, and Holocene time scale resolution.

Thus, with the case of two ancient forest studies in the French South Inner Alps (Queyras) we can see how pedoanthracology provides results and their potentials and limits. During this project we tried to determine how this approach can provide information usable for naturalness assessment. After data extraction and exploitation, information obtained in terms of species composition, space distribution and vegetation dynamics proved that pedoanthracology is a very useful and reliable tool for naturalness analysis. Particularly because it gives specific palaeoecological indications on the Holocene time scale and the ligneous vegetal community space scale. The current study deals with disturbances and vegetation dynamics in northern Germany as documented by anthracological and dendroecological approaches. We can see how pedoanthracology could be one part of a multidisciplinary approach, integrated into an interdisciplinary context within the interdisciplinary graduate school: “Integrated Studies of Human Development in Landscapes” (Christian-Albrechts-Universität zu Kiel). For this study we use different scientific tools: 1. micro-anthracology analysis 2. pedoanthracological analysis 3. dendroecological analysis, and cooperates links with other disciplines like geomorphology, archaeology, palynology, etc.

The global aim of the research project is to obtain a data matrix with precise information for time, space and source of disturbances, resulting from the interdisciplinary and multidisciplinary approach which will be a contribution to the understanding of human development in landscapes.

The theory of alternative stable states in shallow lakes. Macrofossil research of lake development

Dierk Michaelis
Institute for Botany and Landscape Ecology; E.-M.-Arndt-Universität Greifswald; Grimmer Str. 88;17487 Greifswald

Historical observations showed that some shallow lakes in Central Europe and southern Scandinavia switched between clear water and turbid water phases [1]. Submersed macrophytes dominate the phases with clear water while algae develop excessively during turbid water phases. Several feedback mechanisms are discussed for stabilization of the different states. But until now, there is little paleoecological research done about long-term development of such lakes.

In a project of the Universities of Rostock and Greifswald five lakes in northern Germany were involved in a multi-proxi research (macrofossils, pollen, geochemistry) on the sediments of the last thousand years. The main focus of the macrofossil part laid on the development and combination of life form spectra, e.g. submersed, natant or emergent plants. The composition of the macrofossil assemblages is interpreted as a reflection of light and nutrient availability. The study included lakes of different water chemistry which coincides with different botanical composition of the lake sediments. Lakes with *Chara*-dominated vegetation could be easily distinguished from lakes with *Nitella-Isoetis* vegetation. In both types of lakes changes occurred from stages rich in diaspores of these plants to stages dominated by remains of Nymphaeaceae. The changes were not regularly and rather occasionally. In comparison of the lakes the stages covered different time spans and were not synchronous. This would possibly support the assumption of internal driving factors.

[1] Hargeby, A., Blindow, I. & Andersson, G. (2007): Long-term patterns of shifts between clear and turbid states in Lake Krankesjön and Lake Tåkern. Ecosystems 10: 28-35.

Importance of modern regional data sets for palaeoecological inferences

Larisa Nazarova, Ludmila Pestryakova, Ulrike Herzschuh, Diekmann Bernhard
Alfred Wegener Institute for Polar and Marine Research (AWI)
Yakutsk State University, Yakutsk, Russia; 2 AWI Potsdam.

Reconstruction of the dynamic elements of past environments is extremely important for understanding both the present state and evolutionary trends in future climate development. Since long-term measurements on climate variability very rarely go back more than about 100 years, palaeoclimate and environmental reconstructions based on proxy indicators must be used to validate the output of global climate models. Especially important such reconstructions are in climatologically sensitive and pristine regions such as polar areas, where any small global climate change result in distinct regional variations of temperature, precipitation, and other climate-induced changes. There are few examples of quantitative palaeoecological studies in Siberia and these data have to be tested by quantitative studies from other sites in this region, inferred from other proxy and using regional calibration datasets and temperature models that were still lacking. At the present state of knowledge, biological indicators from aquatic and terrestrial environments are the most reliable proxies, because they react sensitively to climate change and define different aspects of environments, which should be assessed together for reliable reconstructions. The basis, however, of all quantitative reconstruction approaches are regional calibration datasets from which the empirical reconstruction model (i.e. the transfer function) will be established. Calibration datasets for reconstructing palaeoclimate variables were most effectively established along steep latitudinal temperature gradients in Northern Europe and Canada. But any application of non-regional models for reconstruction causes difficulty in their interpretation and makes results sometimes controversial. One of the premier methods for quantitative temperature reconstruction in temperate and arctic environments is by means of chironomid-climate inference models. Chironomids compose a family of true flies and are well suited as quantitative indicators of climate change. Merging together data sets from Northern and Central Yakutia gives us a data set and Combined Temperature model with a good statistical parameters. The model can be applied to sediment cores from Northern Russia in order to obtain reliable temperature reconstructions of Holocene.

Late Quaternary Vegetation History and Climate Dynamics of Westerlies and Indian Monsoon in Central Nepal

Frank Schlütz (1), Wolfgang Zech (2), Georg Miehe (3) & Hermann Behling (1)
(1) University of Göttingen, Palynology and Climate Dynamics, Untere Karspüle 2, 37073 Göttingen
(2) University of Bayreuth, Institute of Soil Science and Soil Geography, 95440 Bayreuth
(3) University of Marburg, Faculty of Geography, 35032 Marburg

Over the last years analyses of pollen, spores and other non-pollen palynomorphs as well as geochemical analyses have been carried out on several lake cores from Central Nepal taken in altitudes between 3500 – 4050 m asl. The results enhance our knowledge about vegetation history and climate dynamics of the past 18.000 years. Since 2007 we started a new DFG-project to extent our interdisciplinary research in Palynology, soil sciences and biogeography. The focus is to compare palaeoecological archives from the moisture gradient Outer - Inner - Tibetan Himalaya in eastern Central Nepal (Langtang/Helambu area) and more to the west in the Annapurna region.

One special focus is to enlighten the role of winter/spring precipitation brought by the westerlies for the chorology of conifers from the western Himalaya having their recent eastern distribution limit in Nepal. From our palynological results we can conclude that *Cedrus deodara* and *Picea smithiana* occurred about 150 – 200 km further to the east until the end of the so called Heinrich 1 event until about 15.000 years ago [1]. Around that time deciduous forests with *Juglans regia* (walnut) and *Ulmus wallichiana* (elm) were a more dominating vegetation type than afterwards. These forests resemble the "mid-montane winter-deciduous forest" [2] and may have been pioneers on the unstable slopes after the Last Glacial Maximum. [1]. With the onset of the Indian monsoon the portion of summer precipitation increased significantly and eastern taxa became more frequent (*Tsuga dumosa*, *Engelhardia spicata*) or appeared for the first time in the Late Quaternary (*Podocarpus neriifolius*).

During the Holocene human influence on the vegetation increased dramatically. First palynological hints date back to over 5000 years [3]. The rich *Rhododendron* shrubs and forests seem to be the result of man made fires [4].

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Natural versus anthropogenic processes in mire development - a case study in northern Japan

Stefan Hotes
University of Giessen, Department of Animal Ecology; Heinrich-Buff-Ring 26-32, 35392 Giessen, Germany

Reconstruction of long-term dynamics of ecosystems is a key for the understanding of natural and anthropogenic drivers of ecological change. Palaeoecological methods allow to evaluate the role of human activities on time scales that exceed the period for which direct scientific records are available. In order to separate human influence from natural processes, study sites with a well-documented history of human intervention are particularly useful. Mires in Hokkaido, northern Japan offer suitable conditions for such investigations, as major anthropogenic changes at the landscape level occurred only after colonization by ethnic Japanese in the late 1800s.

Results of plant macrofossil and testate amoebae analyses of cores from a transect spanning the mire center - mire margin gradient at Sarobetsu Mire in northern Hokkaido, Japan, are presented. The current vegetation consists of *Sphagnum*-dominated communities in the mire center and communities dominated by dwarf bamboo (*Sasa*) in the marginal area. *Sasa* is invading the *Sphagnum*-dominated vegetation, which is of great concern both for nature conservation and tourism that relies on the *Sphagnum*-dominated vegetation as a resource. Hydrological change, namely the lowering of the water table and faster run-off due to drainage in the catchment area is thought to be the main factor determining plant succession. However, details in relation to the timing of the onset of vegetation change and the relative importance of human activities are largely unknown.

The current study addresses these issues through the analysis of hydrological and vegetation change using testate amoebae and plant macrofossils as proxies. It is part of an interdisciplinary research project that aims to provide baseline data for ecological restoration. Comparisons with data on modern hydrology and palaeoecological reconstructions based on pollen analysis supplement the results, and implications for mire restoration will be discussed.

Grassland dynamics in South America throughout space and time

Lisa Schüler & Hermann Behling
Department of Palynology and Climate Dynamics, Albrecht-von-Haller Institute for Plant Sciences
Untere Karspüle 2, 37073 Göttingen - Germany

In this pilot study we made the attempt to distinguish between different South American grassland types in space and time, based on pollen morphological characteristics of the Poaceae family. For this purpose Poaceae pollen grains from sediment core samples of four different grassland types were measured. We investigated pollen from Páramo in Ecuador, the Campo do Altitude in the south-eastern Brazilian highlands, the Campos in southern Brazil and Pampa in Argentina dated between the late Pleistocene and the late Holocene. Statistical analyses of the data show significant differences between the grassland types. Furthermore, by creating pollen size classes we could find grassland type specific size class compositions. Our results reveal a highly dynamic development of the individual grassland types; they also give us interesting information on composition patterns, development and possibly changes in biodiversity within these ecosystems. Moreover, our data provide an indication for the state of the Campos ecosystems in the southern Brazilian highlands during the late Pleistocene which is still an unsolved and controversial issue in palaeoecology.

Tropical Mountain Forest dynamics and environmental changes in the northern Andean biodiversity hotspot during the late Quaternary

Hermann Behling, Corinna Brunschön, Holger Niemann, Fernando Rodriguez
Department of Palynology and Climate Dynamics, Albrecht von Haller Institute of Plant Sciences, University of Göttingen, Untere Karspüle 2, 37073 Göttingen, Germany,

The mountain ecosystems of the neotropics, such as different mountain rainforests and páramos, especially in the northern Andes harbor the most biodiverse ecosystems on planet earth. We know only little about the reasons for this biodiversity. We are especially ignorant of the role that history has played in the development of these hotspots of species endemism and richness. Despite the importance to understand the landscape dynamics, in particular in hotspots of biodiversity, for management and conservation only little is known on its environmental history. New palaeoecological studies from the southern Ecuadorian Andes provide interesting insights on vegetation, fire and climate dynamics as well as human impact during the late Quaternary.

Investigations of the genetic structure of *Laurus azorica* (Franco) Seub. in the Canary Island cloud forest

Barbara Rudolph (1), Ina Galinsky (1), Sabrina Schmidt (1), Anna Maria Vogt (1), M. Soledad Jiménez (2), Domingo Morales (2), Agueda M. González-Rodríguez (3), Ángel B. Fernandez Lopez (4), Jens G. Rohwer (1)
(1) University of Hamburg, Biocenter Klein Flottbek, Ohnhorststr. 18, 22609 Hamburg, Germany
(2) University of La Laguna, DPTO. Biologia Vegetal, 38207 La Laguna, Tenerife, Spain
(3) Dpto. Fruticultura Tropical, Instituto, Apdo. 60, 38200 La Laguna, Tenerife, Spain
(4) Parque Nacional de Garajonay, Carretera General del Sur 6, 38800 San Sebastian, La Gomera, Spain

In the Tertiary, laurel forest was widespread from Central Europe to North Africa. The northern most fossils of *Laurus* were found near Cologne and are dated to the Miocene. During glaciation in the Pleistocene the laurel forest almost disappeared from the European and African mainland. Today, some residual fragments still can be found on the Canary Islands, Madeira and the Azores, sheltering a very high proportion of endemic plant species (75%), being either Canarian or Macaronesian endemics. Although these forests also play an essential role for the drinking water resources on the islands, these relics are threatened by human impact as well as global warming.

In this study, the molecular population structure of the character species of this cloud forest, *Laurus azorica* (Franco) Seub., from the Canary Islands (La Palma, La Gomera, El Hierro, Tenerife and Gran Canaria) was examined in order to a) investigate the immigration pathway to these volcanic islands and b) gain insight into the population structure and variability of the respective residual populations with the aim of supporting a sustained conservation and reforestation of this threatened vegetation type.

AFLP analyses of leaf material from 123 trees were carried out, comprising 10 to 36 individuals per island, depending on sizes of the remaining forest stands. Samples of the sister species *L. nobilis* from Portugal and France were included to understand the speciation process of *L. azorica* from the common ancestor while immigrating to the Canary Islands. Genetic distances were estimated using UPGMA, Neighbor Joining and PCO analysis. Furthermore, the development of microsatellite markers is in progress.

The genetic analyses showed a differentiation among populations of *L. azorica* from different islands. Also, we could reconstruct the probable main direction of colonization from island to island from east to west as well as on the different islands. Populations on Tenerife are found in two different clades. The eastern populations clustered together, showing low genetic distance also to samples from El Hierro. The western population is linked to those from Gran Canaria. La Gomera possesses one large and continuous cloud forest area with a small subpopulation separated genetically from the main population, suggesting two different origins. In accordance with results of Arroyo-Garcia et al.[1] it was not possible to separate *L. azorica* from its sister *L. nobilis* in Europe so far, as these samples grouped within the Gran Canaria cluster of *L. azorica*. Further analyses on this topic are in progress.

[1] Arroyo-Garcia et al. 2001: Euphytica 122: 155 – 164.

Poster presentations

Ecosystem changes since the late Pleistocene at Cerro Toledo in the Podocarpus National Park, south-eastern Ecuadorian Andes

Corinna Brunschön and Hemann Behling
Department of Palynology and Climate Dynamics, Albrecht-von-Haller Institute for Plant Sciences, University of Göttingen, Untere Karspüle 2, 37073 Göttingen,Germany,

The palaeoenvironmental knowledge for the Ecuadorian Andean biodiversity hotspot is still relatively poor. Therefore palynological studies are carried out in the Podocarpus National Park (PNP) region in South Ecuador. Sediment cores of adequate bogs and lakes were taken for investigation since 2005 within the DFG Research Group 816 (former 402). New results of two bog cores (CT/CTB) from Cerro Toledo, located at 3148 m a.s.l. in the southern part of the PNP, are presented here. Considerable ecosystem changes is found for the late Quaternary followed from the CT record, going back to the late Pleistocene, and the CTB high resolution record for the Holocene. Páramo with a high proportion of Plantago rigida was the main vegetation during the late Pleistocene since ca. 20,000 cal yr BP, indicating cold and wet climatic conditions. Due to the high presence of Isoëtes till the end of Pleistocene (ca. 11,500 cal yr BP) there must have been humid conditions facilitate shallow water bodies at the study site. Since ca. 16,200 cal yr BP páramo decreased while mountain rainforest developed. This trend gradually continued over the end of Pleistocene to early Holocene times till ca. 8,600 cal yr BP. At that time there was the most extensive distribution of mountain rainforest, reflecting a temperature warming till a climate optimum was reached. From ca. 8,500 cal yr BP onwards páramo vegetation recovered and mountain rainforests decreased, suggesting a cooling of the climate. There can be observed an alteration of páramo type over the time as Plantago rigida and Apiaceae disappeared after Pleistocene times, whereas Poaceae and Cyperaceae got the most important plant families forming a grass páramo composition along with a prevailing Sphagnum bog. From 1,800 cal yr BP to present time mountain rainforests seemed to increase slightly indicating a slow warming to present day temperatures. Fire events got more frequent after 1,800 cal yr BP especially in recent times in combination with road constructions. This suggests rather anthropological than natural caused fires. In comparison with other results of the PNP area (e.g. at Rabadilla de Vaca site and El Tiro Pass), it can be assumed that the primary changes in vegetation composition are representative events for the hole PNP region, even though there remain local small-scale variations.

Past vegetation, climate and fire dynamics in Serra do Tabuleiro, southern Brazil

Jeske-Pieruschka, V. & Behling, H.
Department of Palynology and Climate Dynamics, Albrecht-von-Haller-Institute for Plant Sciences, University of Göttingen, Untere Karspüle 2, 37073 Göttingen – Germany

Detailed pollen and charcoal analyses of a 169 cm long core from Parque Estadual da Serra do Tabuleiro, located on the coastal highlands of southern Brazil, will be used to understand the dynamic of the Atlantic rain forest on the slopes and the Araucaria forest-grassland (campos) mosaics ecosystems at higher altitudes. Climatic and vegetational changes as well as anthropogenic activities will also be investigated. The Ciama core (875 m elevation), dated at 43,450 cal yr BP, will give answers to the question if this campos on Serra do Tabuleiro is natural and if fire occurred. Furthermore, we are interested in, where the isolated Araucaria Forest comes from, and whether these patches could be relicts from a glacial refugia. Campos was the dominating vegetation during the past until the beginning of forest expansion after the mid Holocene. Our preliminary results based on palynological and charcoal analyses provide an overview on the dynamic of these neotropical ecosystems during the late Pleistocene and Holocene. These species rich ecosystems and their development processes have to be understood for an appropriated planning in management, and consequently their conservation.

Interdisciplinary historic approaches as key for the sustainable conservation of a unique pond bottom vegetation

Henriette John (1), Hermann Heilmeier (1), Jens Kugler (2), Rita Hempel (3), Thomas Kasper (3), Gerhard Daut (3)
(1) TU Bergakademie Freiberg, Institut für Biowissenschaften, AG Biologie/Ökologie, Leipziger Str. 29, 09599 Freiberg, Germany
(2) TU Bergakademie Freiberg, Institut für Wissenschafts- und Technikgeschichte, Fuchsmühlenweg 9 (Reiche Zeche), 09599 Freiberg, Germany
(3) Friedrich-Schiller-Universität Jena, Institut für Geographie, Löbdergraben 32, 07743 Jena, Germany

In the centre of the old mining region Erzgebirge (East Germany) there is a historic man-made water system, consisting of ponds, water ditches and subterraneous trenches. Initiated in the early 16th century to store water for the operation of mining machines, this system is still used today even for drinking and process water supply, fishery as well as recreation and is protected as a historic monument.

Beside those outstanding features, the ponds have a pan-European relevance for nature conservation. They inhabit vegetation of Littorelletalia and Isoeto-Nanojuncetea in common, which can hardly be found elsewhere. Furthermore the vegetation of Isoeto-Nanojuncetea includes the endangered and protected *Coleanthus subtilis*.

The history and the continuous specific use of the water system with intensive water level fluctuations was the basis for the colonisation by those species, but has not been considered so far within nature conservation measures. The vegetation history of the ponds from their construction until the early 20th century is unknown. It is not clear when and in which pond the species immigrated first, how they dispersed from one pond to the other and how different use forms influenced the species composition and abundance over this period. Particularly against the background of major changes in the use and management of the system to be expected in future, it is uncertain what the consequences will be for this unique vegetation. So it is very important to learn from the history.

Within the DBU funded project “GehVege” foundations for the sustainable conservation of the unique vegetation here and a methodological example for the derivation of nature conservation measures for similar ecosystems elsewhere will be elaborated. Beside vegetation ecological measures interdisciplinary approaches are performed to study the natural sediment archives. This includes analyses of plant macro-remains and a wide range of physical and geochemical properties of the sediments as well as their changes during time. These data will be completed by historic archival data studies like land use or high flood events. First results indicate colonisation of these ponds by *Coleanthus subtilis* for at least 3 centuries and a first chrono-stratigraphy is established on the base of detected sand layers in selected sediment cores taken from the ponds.

Holocene environment dynamics of the Western Eifel region, Germany, quantified by pollen and stable isotopes

Norbert Kühl (1), Robert Moschen (2), Stefanie Wagner (1), Andreas Lücke (2), Thomas Litt (1)
(1) Steinmann Institute of Geology, Mineralogy and Paleontology, section Paleobotany; University of Bonn, Nussallee 8, 53115 Germany;
(2) Institute of Chemistry and Dynamics of the Geosphere; Agrosphere (ICG-4), Forschungszentrum Jülich, 52425 Jülich, Germany.

Comparison of different proxies from terrestrial sedimentary records helps in disentangling the complex factors influencing the stable carbon isotopic composition of moss cellulose and lacustrine particulate organic matter (POM). This is particularly important for the reconstruction of Holocene climate variability, which became second to the general increase in anthropogenic impact on the environment.

This study aims at reconstructing Holocene paleoclimate and paleoenvironment of the Western Eifel region, Germany, based on a multiproxy approach. Lacustrine sediments from Lake Holzmaar and *Sphagnum* peat from Dürres Maar provide proxies from two very different, but close (600m) archives. From both deposits, pollen and macro remains allow for the interpretation of vegetation and climate history based on paleobotanical evidence. Lacustrine POM from annually laminated sediments of Lake Holzmaar [1], and moss cellulose from Dürres Maar were used for stable carbon isotope analysis.

Numerous AMS ^{14}C dates provide an independent chronology of the Dürres Maar record and supports the comparison based on biostratigraphy with the Lake Holzmaar archive. Both records are the basis for quantitative paleoclimate estimates using a recently developed probabilistic method [2] that can incorporate pollen as well as macro fossils. The method is based on probability density functions (pdfs) and provides a most probable reconstructed climate and an uncertainty estimation [3]. It is an indicator taxa approach based on presence/absence that can use all taxa, but allows to exclude taxa that are commonly interpreted as anthropogenic indicators.

Strong changes are recorded for the last 4.000 years in both pollen records and in the stable carbon isotope record from Lake Holzmaar. In contrast, stable carbon isotopes from the *Sphagnum* peat Dürres Maar show relatively stable climatic conditions during the last 4.000 years. This is supported by the climate reconstructions with the pdf-method that also show low variability. Consequently, anthropogenic influences on landscape and the lacustrine ecosystem are sufficient to explain the abrupt shifts in the stable carbon isotopic composition of POM from Lake Holzmaar. In contrast, changes between ca. 8.500 a BP and 4.000 a BP can be attributed to climate oscillations, in particular in winter temperature and precipitation. This includes the period around 5.000 BP as well as the 8.2 ka event, which, however, is not as pronounced as in more sensitive regions such as Scandinavia.

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The 2010 target and beyond – Challenges for conservation biology and policy

6.1. Assessing European policy impacts on biodiversity

Ben Delbaere, Mark Snethlage

Oral presentations

GLOBIO3: Framework to asses global terrestrial biodiversity: options to reduce biodiversity loss in Europe

Rob Alkemade, Mark van Oorschot, Ben ten Brink
Netherlands Environmental Assessment Agency (MNP) PO Box 303, 3720 AH, Bilthoven., The Netherlands

The GLOBIO3 framework was developed in order to evaluate human induced changes of biodiversity in the past, present and future. The model is built on clear and transparent relationships between pressure factors and biodiversity impacts, based on state-of-the-art knowledge. The pressure factors or driving forces of biodiversity loss considered are land cover change, land use intensity, fragmentation, climate change, atmospheric nitrogen deposition, and infrastructure development. The relationships are based on published data from literature or, in the case of climate change on niche based models. GLOBIO3 describes biodiversity by the remaining mean species abundance of original species, relative to their abundance in undisturbed primary vegetation, This indicator of relative mean abundance (MSA) is similar to the Biodiversity Intactness Index[1].

Policy options are evaluated by linking the GLOBIO3 model with existing assessment tools such as the IMAGE2.4 model[2]. Issues that can be addressed with GLOBIO3 on a regional to global scale include: (i) the impacts of human pressures on biodiversity and ecosystems and their relative importance; (ii) expected trends in mean species abundance (under various future scenarios); and, (iii) the likely effects of various policy response options.

In this presentation I first introduce the GLOBIO3 framework, and show results of the evaluation of different global- and European scale policy options that might be assumed to reduce the rate of biodiversity loss and hence help to achieve the Convention on Biological Diversity’s 2010 biodiversity target. These options are: climate change mitigation through expanded bio-energy use, an increase in plantation forestry, and an increase in protected areas. The possible consequences for biodiversity of some options in European rural development, derived from the EURuralis-project, will also be presented[3] .

[1] Scholes RJ, Biggs R. 2005. A biodiversity intactness index. Nature 434:45-49
[2] MNP. 2006. Integrated modelling of global environmental change. An overview of IMAGE 2.4. Netherlands Environmental Assessment Agency (MNP), Bilthoven, the Netherlands
[3] Rienks W.A. (ed.). 2008. The future of rural Europe. Wageningen University Research and Netherlands Environmental Assessment Agency. Wageningen. The Netherlands

Linking expert scientific knowledge to policy: a qualitative assessment of future risks to European biodiversity

Glenn Marion (1), Ralf Grabaum (2), Stijn Bierman (1), Adam Butler (1), Joachim Spangenberg (3), Ingolf Kühn (3) Josef Settele (3), Philip E Hulme (4), Jean-Marc Douguet (5), Kaja Peterson (6), Isabelle Reginster (7), Volker Grescho (2), Laura Maxim (5), Ines Omann (8)
(1) Biomathematics & Statistics Scotland, JCMB, Kings Buildings, Edinburgh EH9 , UK
(2) OLANIS Expertensysteme GmbH, Permoserstr. 15, 04318 Leipzig, Germany
(3) Umweltforschungszentrum Leipzig Halle GmbH, Theodor-Lieser-Str. 4, 06120 Halle, Germany
(4) Bio-Protection and Ecology Division, PO Box 84, Lincoln University, Lincoln 7647, Canterbury, NZ
(5) Université de Versailles Saint-Quentin-en-Yvelines, 47 Bd. Vauban, 78047 Guyancourt cedex, France
(6) Säästva Eesti Instituut, Stockholmi Keskkonnainstituudi Tallinna Keskus (SEI-Tallinn),Lai Street 34, 10502 Tallin, Estonia
(7) Dpt of Geography, Université de Louvain, Place Pasteur,3,-B- 1348 Louvain-la Neuve, Belgium
(8) Sustainable Europe Research Institute (SERI), Garnisongasse 7/27, 1090 Wien, Austria

Decision makers need to understand how the policies they adopt could impact upon future biodiversity, and in turn upon ecosystem services. The ALARM project has aimed to do this, at a European level, by (1) developing a common set of scenarios for future policy, and describing (both qualitatively and quantitatively) the impact of these policy changes upon key pressures for biodiversity, and (2) assessing the consequent impacts of these changes upon biodiversity and ecosystem functioning in terrestrial and freshwater ecosystems. The project is highly multi-disciplinary – involving socio-economists and natural scientists from a diverse range of different disciplines – and the task of summarising the scientific conclusions within a common, policy-relevant format has therefore been a challenging one. We present a novel questionnaire-based approach that has been used within ALARM to summarise and synthesise expert knowledge regarding risks to biodiversity. The approach aims to provide a common framework for comparing the relative impacts of different scenarios and pressures upon biodiversity, and for comparing these impacts across taxa, ecosystem types and biomes, all in the context of a specific future year (2050). Overall comparisons between scenarios are of relevance to policy makers, whilst the more detailed results can provide a mechanism for identifying counter-intuitive results and possible knowledge gaps (which may, in turn, point towards potential new avenues for research). The approach that we have adopted is iterative, since it is designed to standardise assessments in such a way that the results can be compared between individuals and - to a more limited extent - between scientific groups. Specifically, the process has involved:

(a) familiarising people with the scenarios and with the aims and structure of the questionnaire;

(b) using group discussions to explore - and, where possible, agree upon - the selection of appropriate spatial scales, operational definitions of biodiversity, and methods for treating interactions between pressures;

(c) completion of questionnaires by individual scientists;

(d) group discussion and feedback.

It is intended that the process will conclude with a collective interpretation of the results. In this talk we outline the details of the methodology, describe the advantages and limitations of the approach that we have adopted, and present initial results.

MACIS: Minimisation of and adaptation to climate impacts on biodiversity - Policy analysis and options study

Jake Piper, Elizabeth Wilson
Oxford Brookes University, OXFORD OX3 0BP, United Kingdom

The MACIS project is investigating measures to address climate change impacts on biodiversity. The Policy analysis workpackage has carried out a policy review at EU and national level, examining the current state of policy on climate change and biodiversity and reviewing policy issues surrounding mitigation and adaptation impacts upon biodiversity. The aim has been to identify where the policy gaps lie, how the assessment process can be improved and what research needs are.

Documents reviewed include selected strategies/plans at EU and national level for both climate change as well as climate change and biodiversity; also, EU sectoral policy, to identify policies on climate change and biodiversity. We have also explored options for responses by sectors to cumulative effects upon biodiversity and have reviewed the use of scenarios/futures work as a tool for policy development. In addition we have worked on policy/plan assessment measures (of impacts, compliance) for policy integration.

Our findings to date show that, whilst climate change and biodiversity are increasingly considered in planning and policy, more work is needed to achieve desired goals. In particular, high-level sectoral policies (e.g. transport, tourism, agriculture) rarely consider or make allowance for biodiversity, even when biodiversity underpins the sector. There exists a patchwork of measures and proposals, offering protection for biodiversity, but it is not comprehensive or fully integrated. A good deal of scenarios/futures work is in progress and offers significant value for upgrading assessment of future change, though it has not always been used. Impact assessment procedures offer prospects for better control of impacts on biodiversity, but need further development; for example, impact assessment must cover the range of cumulative impacts (linking impacts of climate change, of mitigation and adaptation and of other pressures) upon biodiversity.

The research has shown that we have in place some of the elements necessary to safeguard biodiversity, through policies to protect species, habitats and sites; means of predicting impacts and trends (data, modelling, scenarios); strategies and action plans on biodiversity protection; measures (landscape scale/connectivity, etc.), these must be strengthened and enforced. Other elements required - and these are available to a variable extent - include:

- the necessary authority to ensure policies are followed and measures are implemented;
- funding for protection and enforcement;
- space for biodiversity: land, wetland and water space, where necessary with appropriate designations, and
- continuing research.

Assessing the impacts of CAP reform on farmland bird distribution in England and Wales

J. Tzanopoulos (1), P.J. Jones (2) & S.R. Mortimer (1)
(1) Centre for Agri-Environmental Research, School of Agriculture Policy and Development, University of Reading, PO Box 237, Reading, RG6 6AR
(2) Centre for Agricultural Strategy, School of Agriculture Policy and Development, University of Reading, PO Box 237, Reading, RG6 6AR

Agricultural intensification has been widely acknowledged as a key driver of the decline on farmland biodiversity. The recent CAP reform decouples payments from productivity and is likely to have impacts on the intensity of agricultural production. However, it remains unclear how this policy shift will affect farmland biodiversity. In this paper we investigate the impacts of recent CAP reform on the distribution of farmland birds in England and Wales.

We followed an interdisciplinary approach combining economic and ecological modelling. We used the Land Use Allocation Model (LUAM) to project likely changes in land use consequent upon changes in agricultural policy. Based on concurrent data from the Breeding Bird Atlas, the Land Cover Map of the UK and the Defra June Agricultural Census, we built habitat suitability models for 25 farmland species using GLM and CART. We combined LUAM output data and habitat suitability models to assess if the habitat and management requirement of each species in each 10km square will be met under CAP reform and we obtained predictions for the future spatial distribution of the farmland birds.

The LUAM predicts significant changes in the production and spatial distribution of enterprises following CAP reform. However, the response on the distribution range of farmland birds differs among species. Ten species show an increase in their distribution, two species remains the same, while thirteen species show a small decline (less than 8%) and five species suffer a distribution decline higher than 10% compared to 1990. The changes in the distribution range of the species are not accompanied by significant changes in their spatial distribution; the average similarity (Jaccard index) of the spatial distribution between 1990 and future prediction is 0.9.

The impacts of the recent CAP reform on farmland birds do not follow a clear pattern. Although CAP reform is likely to increase extensification in parts of England and Wales, and this benefits the distribution of certain farmland birds, agriculture intensification continues in part of eastern and central England leading to further decline of farmland birds. The CAP reform has often been presented in policy documents as a milestone in the process of shifting the policy focus from production towards environmental and rural development benefits. However, large scale policies such as CAP and its reform can not always reverse species decline and guarantee biodiversity conservation and thus it is need to be accompanied by regionally designed conservation plans.

Poster presentations

Afforestation impact on biodiversity in SE Spain: environmental variables effects.

M.ª Noelia Jiménez (1), Francisco B. Navarro (1), Emilia Fernández-Ondoño (2) & Mª Ángeles Ripoll (1)
(1) Grupo de Sistemas y Recursos Forestales. Área de Producción Ecológica y Recursos Naturales. IFAPA, Centro Camino de Purchil (CAP, Junta de Andalucía) Camino de Purchil s/n. 18080 Granada (Spain). E-mail: noelia.jimenez.ext@juntadeandalucia.es
Telephone no: +34958895233. Fax: +34958895203.
(2) Dpto. Edafología y Química Agrícola. Facultad de Ciencias. Universidad de Granada. Campus Fuentenueva s/no. 18071. Granada (Spain).

This study evaluates the impact of afforestation programmes of the Community Agrarian Policy on biodiversity. Several environmental characteristics (edaphic, climatic and geographic variables), and floristical data (species richness, abundance, Shannon index, cover), were monitored in 51 afforestations in the Northeast of Granada Province (SE Spain) carried out between 1993-2001 period. This study area covered an area of 5220 km^2 where the afforestations were selected by geological substrate (siliceous, limestone, saline, etc...), afforestation age and previous land use (old fields or cereal crops). The selected area is the 25 % of the total afforestation of Granada Province. Multivariate analyses DCA, CCA, variance partitioning procedure,…) were performed using CANOCO Programme (v. 4.5). Variability of floristic data was significantly explained by a high number of environmental variables, specially edaphic characteristics as electrical conductivity, potassium concentration, % nitrogen, soluble calcium, % calcium carbonate, etc. We found high Shannon index (medium value 2.38 ± 0.07SE, rank 0.65-3.20, n=51), with greater values than reported in cereal crops (1.14 ± 0.09SE, n=7). Calcium carbonate, soluble calcium and soluble potassium were negative correlated with Shannon index. Organic carbon, soil water content at 1500 kPa and soluble potassium were negative correlated with species richness. Organic carbon was also higher in afforestations than cereal crops. The soil organic carbon increased 49.32 % (n=7) in afforestations.

According to this result, afforestation of agricultural lands is properly for biodiversity conservation. We propose some management lines to improve biodiversity in afforestation lands.

Assessment of ecosystems services as a part of water and land management in the Tisza River Basin

Elena Livia Minca, Katalin Petz, Rik Leemans, Saskia Werners
Wageningen University and Research Centre, Costerweg 50, Building no. 400, 6701 BH Wageningen, The Netherlands

Providing ecosystem services – the benefits people obtain from ecosystems – is strongly dependent on the capacity of natural processes and ecosystem functioning. The inclusion of ecosystem services in spatial and policy planning is important, since the services are highly influenced by climatic conditions, water management and the institutional context. In Hungary and Romania the required scientific research for the consideration of ecosystem services in spatial planning and in the institutional context is weak. The Tisza River Basin, which is shared by these two countries, is increasingly facing the impacts of floods and droughts. In order to mitigate their effects and to sustain human well-being an integrated approach combining transboundary water and land management and the institutional context is needed. The ecosystem service perspective can provide such an approach.

This symposium aims at discussing the role of ecosystems services and their importance in two cases of the Tisza River Basin by presenting an assessment of ecosystems services in the context of land and water management schemes, policy framework and climate related extremes. The two cases are both pilot areas for new water and land management plans: (1) the Hungarian Bereg Region, where future flood-retention polder plans have been developed under the European Bereg-INTERREG Neighborhood Programme; (2) the Romanian Crişul Negru Basin where the creation of wet areas along the Crişul Negru River has been proposed by the Ministry of Environment. Fourteen ecosystem services are investigated for the following land cover types: arable land, grassland, forest, orchard, wetland, water body and urban environment. The analysis is done for the plot, landscape and watershed spatial scales.

In this symposium a specific framework will be presented focusing on the performance of ecosystem services and the factors that change it. They are: state of ecosystems, weather extremes, recognition, potential, policy measures and water management plans. Firstly, the link between ecosystems services and water and land management will be discussed. Secondly, the expression of ecosystem services in relevant European and national policy acts will be pointed out. The approach follows the similarities and differences between the two countries. Our contribution to the symposium will highlight the importance of ecosystem services and their consideration, both related to the policy context, weather extremes and water management plans in a transboundary context. The discussion will focus on how an integrated ecosystem services assessment can contribute to decision making and planning.

The 2010 target and beyond – Challenges for conservation biology and policy

6.2. Biodiversity conservation in human dominated landscapes

Paul Opdam, Frank Wätzold, Bruno Baur, Martin Dieterich

Oral presentations

Towards effective ecological knowledge for changing human dominated landscapes

Paul Opdam
Wageningen University Research centre – Department of Land Use Planning,
PO Box 47, 6700 AA Wageningen , The Netherlands

The problems in land use and in ecosystem and biodiversity management are still increasing. The Millennium Assessment (2005) concluded that 60% of the ecosystem functions that are essential to life on earth deteriorate or are not used in a sustainable way, due to human population growth and economic development. The effects of man-induced global warming are predicted to increase exponentially as temperature rise, with accordingly expanding environmental, social and economic damage, in particular in underdeveloped countries. This should augment the significance of science in finding and implementing sustainable solutions. Yet, recent insight in the effectiveness of science suggests a rather poor performance. For example, ecological knowledge is poorly used in spatial planning (1).

In this presentation I will propose and discuss the following seven causes for this inappropriateness of scientific knowledge in land use change.

- Ecological knowledge is often focusing at processes only, without explicit quantitative relations to patterns of landscapes and land use;
- Thresholds in non-linear relationships are relatively unknown, suggesting that ecologists do not realize how important these are for decision making;
- Ecological knowledge on pattern-process (the landscape ecological paradigm) is not linked to value. Yet, spatial planning is about the spatial redistribution of values, not that of processes;
- Values attributed by scientists may be built into predictive models and guidelines, making these tools illegitimate to users;
- Most ecological models are prescriptive linear chains of knowledge, not allowing flexibility for use in the local context of planning areas, and inappropriate to collaborative landscape planning;
- Most ecological models and decision supporting tools may be suitable for policy assessment at large spatial scales, but inappropriate to the local scale, where many land use decisions are being taken;
- Ecological knowledge is often developed in isolation from other scientific disciplines, preventing interdisciplinary solutions.

In summary, most models prescribe positivist, biologically focussed solutions to what are normative, complex conservation problems typically driven by social and economic issues (2). Recent experiences with knowledge co-production show scientists can improve the effectiveness of their knowledge in solving land use problems by developing their methods in interaction with practitioners, and testing its generic value in other case studies [3].

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Modelling and predicting the impact of farming operations on biodiversity

Ph. Jeanneret, D.U. Baumgartner, R. Freiermuth Knuchel, G. Gaillard
Agroscope Reckenholz-Tänikon Research Station ART, CH-8046 Zurich, Switzerland

Land use is an economic activity that generates large benefits but causes environmental impacts. Biodiversity, in particular, has been and is being endangered by e.g. intensive agriculture. Since the relationships between biodiversity and farming operations are complex and manifolds, methods are needed to model and integrate the numerous impact pathways. In the context of Life Cycle Assessment for agriculture, we developed a method for the integration of biodiversity (species diversity) as an impact category (SALCA-Biodiversity). This method aims at assessing the impact on biodiversity of farming operations, systems and farms in a predictive manner, consistently with other impact categories like e.g. global warming potential and energy demand.Biodiversity in the broadest sense of the Rio Convention cannot be totally measured and a single indicator is unlikely to be devised even in agro-ecosystems (e.g. [1]). Instead, groups of indicators should be selected that are sensitive to environmental conditions resulting from land use and agricultural practices, and give as representative a picture as possible of biodiversity as a whole. In the present method, indicator species groups (ISGs) were selected according to their linking to agricultural activities, their habitats and their place in the food chain [2]: flowering plants, birds, small mammals, amphibians, snails, spiders, carabid beetles, butterflies, wild bees, and grasshoppers. We distinguished between the overall species diversity of each ISG and the ecologically demanding species (stenotopic species) in the impact assessment. To estimate the impact of agricultural practices on ISG, inventory data with detailed management options were specified (e.g. quantity of fertilizers). Then a scoring system was developed that estimates the reaction of every ISG to management options according to the relevance of the specific agricultural activity (e.g. fertilization) and of the habitat (e.g. grasslands, cereals). Scores of management options were then aggregated at the field level to compare agricultural systems. The effects of the management options on each ISG as well as the aggregation rules were estimated based on information from literature and expert knowledge. The impact of land use on biodiversity at farm level can be calculated by aggregating the biodiversity scores obtained at field level under consideration of the semi-natural habitats. In a specific case study, several scenarios representing field management options for grasslands and wheat fields were calculated. The results showed the influence of management intensity on most ISGs and the particular managements from which large impacts on biodiversity are to be expected. Conclusively, the method allows to compare impact of agricultural systems on biodiversity and shows biodiversity-friendly practices, and should allow stakeholders to integrate biodiversity conservation strategies in general environmental schemes in agriculture.

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Local and landscape scale effects of organic farming on farmland biodiversity

Doreen Gabriel, Steven M Sait, William E Kunin, Tim G Benton
University of Leeds, Faculty of Biological Sciences, Institute of Integrative and Comparative Biology, Leeds, LS2 9JT, UK

Agri-environment schemes such as organic farming aim to mitigate against declining farmland biodiversity. Research on the potential benefits of organic farming for biodiversity has shown mixed responses for different species groups [1, 2]. Most studies on the effects of organic farming have focused on the differences in field management, but local diversity may as well be influenced by processes operating at coarser spatial scales [3]. Thus, the proportion of organic farming at a landscape scale may affect the response of species groups to organic farming.

We studied 32 paired organic and conventional farms in England, which were nested within matched landscapes of contrasting proportions of organic farming (i.e. on average 1.4% vs. 17.2% organic area in a 10 by 10 km landscape). On each farm three cereal and three grass fields were selected and surveys on earthworms, plants and butterflies were conducted in the centres, edges and margins of the fields. Farmland birds were recorded along two 1km transects across each farm.

The species groups responded differently to field and landscape management. Earthworm density and diversity did not differ between organic and conventional management at either scale. Organic farming at the local scale determined plants in cereal and grass fields with higher diversity and abundance in organic than in conventional fields and more species in the field edges than in the field centres. Butterflies in cereal fields and adjacent margins responded to organic farming at the local and the landscape scales. Their abundance and diversity was higher in field margins than in field centres and higher on organic farms. A significant interaction between local and landscape scale farm management showed that butterfly abundance was highest in organic fields when surrounded by other organic land. Species richness of farmland birds did not differ between organic and conventional farms and was not enhanced by the proportion of organic farming in the landscape.

These results suggest that different taxonomic groups respond to organic management to different degrees and at different spatial scales. The spatial arrangement of agri-environment schemes should be taken into account to effectively enhance components of farmland biodiversity.

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Effects of biogas production on biodiversity

Martin Dieterich
Institute of Landscape Ecology and Nature Conservation (ILN Singen), Burgstrasse 15, D-78224 Singen, Germany

In Europe biomass is one of the central building blocks in strategies targeted at reducing the dependency on fossil fuels. In order to generate energy, biomass can be transformed into biogas (methane), different biofuels or it can be burnt. Overall, the use of biomass in the energy sector will tend to increase intensification pressure in agricultural and forest landscapes with detrimental effects on biodiversity. Problems and possible opportunities for biodiversity conservation relating to the use of biomass in the energy sector will be discussed. Initial results from an ongoing project on the effects of biogas production for species richness in grassland ecosystems will be presented.

Extensively used grassland is a biodiversity hot-spots and endangered habitat type in agricultural landscapes. In Germany grasslands harbour at least 52% of all plant species and 55% percent of the plants that are red listed [1]. In the south German state of Baden-Württemberg, approximately 20 - 25% of the grassland can still be classified as species rich. However, intensification pressures have caused significant loss of such grassland in the past decades and decline is expected to continue as intensification pressures continue to prevail.

It is unclear to what extend biomass used for biogas production contributes to observed intensification of grasslands (fertilization, cutting regime, transformation into agricultural fields). In terms of quality, cut from grassland is inferior to other potential sources for biogas production (e.g. maize). If at all feasible, only multiple cuts from heavily fertilized grassland will yield biomass that can be used in biogas reactors.

In the Baar region (Federal State of Baden-Württemberg) species rich and not intensively use grassland is still quite common. At the same time, biogas production has flourished in the past decade. The region therefore is prone to study possible effects of biogas production on grassland management and associated effects on biodiversity.

In 2008 extensive phyto-sociological assessments of grassland plots were conducted (approx. 200 plots). In order to be able to compare to previous mappings, different methods had top be applied and standardized relative to the Braun-Blanquet approach. Methods include:

agri-environment program assessment schemes (MEKA B4)

mapping schemes for specifically protected biotopes (§24a mapping schemes)

mapping schemes for the assessment of lowland and mountain hay meadows (habitat types 6510 and 6520 according to the EU Habitats Directive).

Results on current status of grassland and development of grasslands between 1995 and 2008 will be presented. In a subsequent step, change in grassland species composition will be associated to the density of biogas reactors in specific areas and to production regimes or changes of production regimes on particular farms.

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The vegetation of agroecosystems – the role of land use and landscape structure

Tsape Aavik & Jaan Liira
University of Tartu, Institute of Ecology and Earth Sciences, Department of Botany, Lai Str 40, Tartu 51005, Estonia

The loss of natural and semi-natural habitats and reduced connectivity between the remaining habitats in agricultural landscapes has caused severe decrease in the biodiversity of these ecosystems. In contemporary agroecosystems, field boundaries are considered as alternative habitats for maintaining plant diversity. Such green veining elements with natural and semi-natural vegetation sustain also environment for pollinators and predator species of agricultural pests. However, as the environmental conditions of such linear edge habitats may seriously be altered by agricultural pollution and mechanical disturbance, the function of boundaries supporting biodiversity and related ecosystem services is questionable. The aim of the present study was: i) to explore the role of field boundaries in the maintenance of plant diversity; ii) to analyse the influence of agricultural activities in the neighbouring field on the plant layer of field boundaries; iii) to study the effect of landscape structure on the vegetation of boundaries.

We described the vegetation of field boundaries and crop-fields in organic and conventional farms of Tartu County in Estonia. We interviewed the farmers to specify the agricultural land use of observed fields and field boundaries. We mapped field boundary type and described the landscape properties around the field boundaries within the circle of different radiuses. Plant species were classified into i) nature-value and ii) agrotolerant species depending on the species' frequency on crop-fields. We analysed the influence of landscape structure and land-use on the diversity of these two species groups separately.

Field boundaries offered habitats to relatively many species, yet, few habitat specialists and practically no rare species were observed. We found that most of the species abundant in crop-fields, i.e. mainly annual weed and nitrophilous ruderal species, were also quite common in field boundaries. However, organic farming significantly supported the diversity of high nature-value species in field boundaries compared to conventional farming. The analysis of species richness implies that the local landscape structure combined with the influence of land-use are the main determinants of local plant diversity while the surrounding landscape properties have less significance.

Farmland biodiversity can be promoted with ecological cross compliance – Experience from Switzerland

Felix Herzog (1), Stéphanie Aviron (1), Heike Nitsch (3), Philippe Jeanneret (1), Serge Buholzer (1), Henryk Luka (2), Lukas Pfiffner (2), Thomas Walter (1)
(1) Agroscope Reckenholz-Tänikon Research Station ART, CH-8046 Zurich, Switzerland
(2) Research Institute of Organic Agriculture FiBL, CH-5070 Frick, Switzerland
(3) Federal Agricultural Research Center FAL, D-38116 Braunschweig, Germany

Agricultural policy has a strong impact on land use and, as a consequence, on farmland biodiversity. More than 100 agri-environment schemes in the OECD countries aim specifically at improving biodiversity. Still, the bulk of government subsidies reach farmers through direct payments, production linked payments, grants for the reduction, control or cessation of production and – indirectly – through export subsidies and import tariffs. Linking ecological standards to these subsidies is a potentially powerful lever for achieving environmental objectives because subsidies contribute substantially to farmers' income.

Ecological cross compliance for the promotion of biodiversity in the wider countryside has been introduced in Switzerland in 1999. In order to qualify for direct payments, farmers have to manage 7 % or more of their land as ecological compensation areas (ECAs). Of the 120,000 ha of ECAs (12 % of Swiss farmland), three quarters are extensively managed hay meadows. Fallows, which are sown with seed mixtures of 20 to 40 herbaceous plant species (wild flower strips) are less important in area (3,500 ha), but are characteristic ECA types for arable regions.

In three regions representative of different farming types (arable, mixed arable–grassland, grassland) in the Swiss midlands, the diversity of vascular plants, butterflies, carabid beetles and spiders was investigated between 1997 and 2004 on ECAs (meadows and flower strips) and conventionally managed fields (n=681).

We observed measurable benefits for flora, butterflies, carabid beetles, and spiders in terms of species numbers and/or composition. The total species lists for plants, spiders and carabid beetles were also significantly more diverse on ECA than on conventional meadows. Moreover, ECA meadows harboured plants (35 species), spiders (32 species), carabid beetles (10 species), and butterflies (2 species) which were not recorded on conventional meadows. On wild flower strip ECAs, there were between 8 % and 60 % more species of plants, carabid beetles and spiders than on arable crops, and the total species lists were more diverse for plants, spiders and carabid beetles. Threatened species, however, were not promoted.

We conclude that environmental cross compliance is effective in promoting agricultural biodiversity in a broad sense. It should be combined with improved agri-environment schemes, in conjunction with nature protection efforts, which target the demanding, threatened species requiring specific conservation efforts.

Agri-environment schemes in Central Europe – the lost opportunity?

András Báldi
Animal Ecology Research Group, HAS, Hungarian Natural History Museum; Ludovika tér 2, 1083 Budapest, Hungary

European landscape is dominated by human activities, like farming. The intensification of farming in the second half of the 20th century deteriorated semi-natural habitats, decreased farmland heterogeneity, diminished resources for farmland species and increased the strength of human impact. In the last decades, agri-environment schemes (AESs) became potential tools to mitigate the effects of intensification, via subsidising farmers to support nature friendly farming. However, AESs are often failed to improve biodiversity [1].

In 1989-1991, the socialist systems of Central- and Eastern European Countries (CEECs) transformed into democracies, causing the total change of economy, including agriculture. The intensity of agricultural management greatly declined; for example, in Hungary fertiliser use decreased by 80%, and 1 million new farmland owners were entered, most with no farming experience. As a consequence, farmland biodiversity increased, as shown by the farmland bird populations index (see Fig. 5 in [2]). Probably other, less studied taxa had similar trends.

These changes are provide a possible explanation for the many failures of AESs in W and N Europe. AESs have simply not enough effect to reduce the consequences of intensification at large scales, the required changes in management are not enough to restore the intensive farmland of W and N Europe. In CEECs, however, all farmlands were included into the "extensification", and the changes were drastic.

The introduction of AESs was a prerequisite for the EU membership in CEECs. Considering the low level of agricultural intensification after the collapse of socialism, the target of AESs in CEECs would be to keep the low level of intensification, carefully selecting prescriptions to support management in some habitats, e.g. in grasslands, which need extensive grazing (or mowing) for conservation, or to reduce management intensity, e.g. via supporting organic farming. AESs do have an extreme big amount of support, at least comparing to previous resources available for nature conservation. Therefore, the situation in the CEECs at the new Millennium was that farmland biodiversity was high and there was the EU's requirement and support (80% of AESs are supported by the EU) for nature friendly farmland management. Thus, ideal circumstances – at least in theory. In practice, however, it seems that this "easy" target was missed: at least farmland bird populations are declining in the CEECs for some years already (see Fig. 3 [3]). Thus, the opportunity to conserve the high farmland biodiversity of the transitional era seems to be lost, in spite of the resources provided by the EU in the form of AESs.

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Ex-arable fields as target habitats for grassland plant conservation – how suitable are they?

Mathias Öster (1), Kristina Ask (1), Sara A. O. Cousins (2) & Ove Eriksson (1)
(1) Department of Botany, Stockholm University, S-106 91 Stockholm, Sweden
(2) Department of Physical Geography and Quaternary Geology, Stockholms University, S-106 91 Stockholm, Sweden

Ex-arable fields transformed to pastures have been suggested as potential target sites for recreation and conservation of species-rich grassland communities. This would also contribute to make larger grazing areas which are economically more sustainable. However, there is a paucity of studies on how suitable ex-arable fields are for grassland species, the temporal scales needed for natural re-assembly of species-rich grassland communities on these habitats, and whether re-colonization is related to dispersal or establishment limitation.

We investigated 19 ex-arable fields that differed in time since pasture grazing commenced (i.e. their age as ex-arable field) and compared them with adjacent species-rich grasslands in terms of species richness of plants, colonization patterns and recruitment ability of 16 sown grassland species. We also compared the functional trait distribution of successful and unsuccessful colonizing species using five traits related to dispersal and persistence: seed mass, seed bank persistence, specific leaf area, plant height and potential for lateral spread.

Species richness increased with field age, but fields did not contain similar species richness as species-rich grasslands even after more than 50 years of grazing. Early colonization into ex-arable fields was not related to any of the investigated functional traits. The rank order in terms of colonizing ability of the species was different between young and old ex-arable fields which suggest that species assembly is either more or less a random process or that species performance changes with field age.

Experimental recruitment of grassland species was generally lower in ex-arable fields than in species-rich grasslands. All species showed this pattern, although the basic recruitment ability varied between species. There were no differences in recruitment among the ex-arable fields, suggesting that dispersal limitation rather than establishment limitation caused the temporal pattern of re-colonization. However, establishment limitation may act as a filter for re-colonization of all ex-arable fields, regardless of their age.

This study demonstrates that the temporal scale for natural assembly of species-rich grassland communities on ex-arable fields extends over 50 years, even when dispersal distances are relatively short. Suggested reasons are a combination of different filters to re-assembly in the form of a field age-independent establishment limitation across species, combined with dispersal limitation that is overcome by species as ex-arable fields become older. Managers that aim to recreate species-rich grassland communities on ex-arable fields should consider introducing seeds or improve germination conditions on their target sites.

Scale-dependent effects of farm structure and management on montane grassland biodiversity

Manuel K. Schneider (1), Irene Weyermann (1,2) & Andreas Lüscher (1)
(1) Agroscope Reckenholz-Tänikon ART Research Station; Reckenholzstr. 191, 8092 Zürich, Switzerland
(2) AGRIDEA, Swiss Association for the Development of Agriculture and Rural Areas; Eschikon 28; 8315 Lindau, Switzerland

Traditionally managed montane grasslands are a biodiversity hotspot threatened by changes in land use management and climate change. Policy adaptation strategies of local agricultural actors as well as traditions are integral drivers of biodiversity in these ecosystems.

We explore links between grassland biodiversity, farm structures and agricultural management at a range of scales from spot to landscape. The basis of analysis is provided by a range of survey studies in several regions in the Eastern and Central Swiss Alps conducted during 2002 and 2006. These studies had the primary aim of investigating effects of types of grazing animals but provide further insights into scale-dependent biodiversity effects of agricultural management.

We find that intra-parcel variability in botanical composition is often equally large than between sites of different management. This is especially true in absence of the equalising influence of mowing. At parcel scale, management intensity interlinked with site characteristics is the primary determinant of plant species richness. Effects of different management strategies (e.g. animal types) are detectable to a much smaller extend in the survey data. The data further show that most agricultural enterprises in the investigated regions manage grasslands covering the whole range of the intensity gradient, but that farm size and the number of animals determine the proportions of land managed at a certain intensity level.

These findings suggest that (A) within-site heterogeneity is an important aspect of montane grassland biodiversity and should be considered more explicitly in such surveys, (B) due to the overwhelming impact on biodiversity, parcel-scale management intensity needs to be well controlled when investigating effects of management strategies (i.e. types of grazing animals) and farming activities, (C) farm structures determine proportions of areas managed at different intensities and have important implications for biodiversity at the landscape level.

The influence of past pasture management on the land snail diversity of nutrient-poor calcareous grasslands

B. Baur, C. Boschi
Department of Environmental Sciences, Section of Conservation Biology, University of Basel, St. Johanns-Vorstadt 10, CH–4056 Basel, Switzerland, bruno.baur@unibas.ch

Changes in agriculture (intensification or abandonment) have resulted in a dramatical reduction of semi-natural grasslands in Central Europe in the twentieth century. Recent management actions aim to restore overgrown and formerly fertilized nutrient-poor grasslands. Former land use is known to influence the present-day vegetation. Similar information is not available for animals with low dispersal ability. We investigated the effect of pasture management history over a period of 55 years on the present-day land snail diversity in 20 dry, nutrient-poor grasslands in the Swiss Jura mountains. Snails were recorded in pastures left unmanaged for 10-40 years but recently cleared from overgrowing shrubs, in pastures fertilized for 15-25 years but recently managed extensively (no fertilizer), and in pastures which have been extensively managed throughout (= control). Past shrub cover had a negative effect on the total number of snail species and individuals and the number of open-land species and individuals. Former use of fertilizer reduced red-listed species and individuals and changed the snail community. Three species (*Vitrina pellucida*, *Helicella itala* and *Abida secale*) were found less frequently in formerly fertilized pastures than in extensive pastures. Our results show that changes in pasture use for a period of 10-40 years alter the land snail fauna. To recover species losses by former intensification or abandonment, corridors connecting intact dry, nutrient-poor grasslands are suggested.

Precipitation and land-use intensity determine the distribution of the bog bush-cricket (*Metrioptera brachyptera*) in fragmented central European calcareous grasslands

Thomas Fartmann, Dominik Poniatowski
Department of Community Ecology, Institute of Landscape Ecology, University of Münster, Robert-Koch-Straße 26, 48149 Münster, Germany, e-mail: fartmann@uni-muenster.de, poni@uni-muenster.de

Based on metapopulation theory, patch size, isolation and habitat quality within sites have recently been identified as the most critical parameters in determining the persistence of species. In the special case of Orthoptera, taking into account the irlow dispersal ability, species survival likely depends more on habitat quality than on patch size and patch isolation.

In summer 2005 we assessed patch occupancy of the flightless bog bush-cricket (*Metrioptera brachyptera*) in 76 study sites (68 calcareous grasslands and 8 further patches) of the Diemel Valley (North Rhine-Westphalia/Hesse, central Germany). Among those, we further selected 26 calcareous grasslands with 80 sample plots to characterise *M. brachyptera* habitats in detail. At each plot, bush-cricket density was sampled using a 0.5 m² biocoenometer.

In 46 (68%) of 68 studied calcareous grassland patches the bog bush-cricket was present. Patch incidence increased with annual precipitation, but was independent of altitude, patch size, isolation and annual temperature. At the microhabitat level (plots), the likelihood of a plot being colonised by *M. brachyptera* decreased with land-use intensity and increased with litter coverage.

In the Diemel Valley, the bog bush-cricket is a typical species of semi-dry calcareous grasslands with a closed turf and low land-use intensity. In combination with sufficient precipitation, these structures generate fresh microclimate near the soil surface that is necessary for successful embryonic development. Given the low explanatory power of patch size and patch isolation for patch incidence, we conclude that conservation of *M. brachyptera* should primarily focus on improving habitat quality within sites.

Resumed management in NE Hungarian mountain meadows – phytomass, diversity, reproduction and soil seed banks

Gábor Matus (1), Péter Török (1,2) Ildikó Arany (2), Enikő Vida (1,2), Béla Tóthmérész (2) & Orsolya Valkó (1)
University of Debrecen, (1) Department of Botany,(2) Department of Ecology,
H-4032 Egyetem tér 1., Debrecen, Hungary

Results of a long-term restoration experiment in *Molinion* fen-meadows and in mesophilous *Cirsio-Brachypodion* grasslands from the species-rich Bohó-meadows, Zemplén Mts., NE Hungary, are presented. Traditional management of the site, early summer mowing yearly, had been abandoned in the early 1970s. After a starting survey management has been resumed in 1993. Vegetation of four managed and four reference lots of 100 m^2 size, with twenty 1 m^2 sized permanent plots in each, was then repeatedly compared. Prior to the management experiment no significant differences in aboveground phytomass, species richness or flowering success have been revealed. Permanent soil seed banks were analyzed in 2005-2006 using the seedling emergence method on early spring samples. Phytomass in fen-meadows has greatly been reduced by resumed mowing. *Molinia arundinacea* phytomass and its flowering frequency as well as aboveground dead have greatly been reduced but phytomass of herbs has stayed much of the same. A significant increase of species richness as well as that of herbs has been wittnessed in mown plots. Flowering frequency of most herbs also increased. In mesophilous grasslands, aboveground living phytomass and aboveground dead of the mown plots has only been moderately reduced. Species richness as well as flowering frequency, except for that of *Calamagrostis arundinacea*, however increased greatly in managed plots. Small grasses and especially herbs benefited from mowing though phytomass of the latter did not differ significantly from that in control.

Fen-meadows had dense seed banks (65,000 to 94,000 seeds/m^2) with medium similarity to vegetation (average of Sørensen index: 0.33) Seed bank dominants were *Juncus conglomeratus* and *J. effusus*. Further frequent species involved *Agrostis canina*, *Campanula patula*, *Carex pallescens*, *Luzula multiflora*, *Lychnis flos-cuculi*, *Potentilla erecta* and *Viola canina*. Contrary, no seeds of the frequent *Achillea ptarmica*, *Gladiolus imbricatus*, *Gentiana pneumonanthe* or *Sanguisorba officinalis* have been detected. Some sedges (*Carex flava*, *C. nigra*, *C. ovalis*) have only been detected in the soil. Most herbs had significantly more dense seed banks in managed plots whereas dominant grasses, *Molinia arundinacea* and *Deschampsia cespitosa* had a higher seed densities in control. Mesophilous grasslands only possessed relatively sparse seed banks (4,800 to 7,000 seeds/m^2) with a low similarity to aboveground vegetation (Sørensen: 0.19). Among frequent seed bank herbs *Stellaria graminea,* while among grasses *Sieglingia decumbens* developed significantly more dense seed banks in the mown plots.

Resuming traditional management seems an appropriate tool to restore still unforested stands of abandoned hay-making meadows. Low similarity of vegetation and seed banks as well as low seed densities in mesophilous stands can be a problem for restoration when overgrown. Species loss of degraded sites can only be overcome by reintroduction of lost species. Similarly, lack of persistent seeds in some species and high density of common sedges in soil can hamper restoration also in fen-meadows.

Prioritizing refuge sites for migratory geese to alleviate conflicts with agriculture

(1)Rikke Anker Jensen, (2) Marys S. Wisz, (3) Jesper Madsen
(1,2,3) University of Aarhus, National Environmental Research Institute, Frederiksborgvej 399, 4000 Roskilde, Denmark

Expanding populations of geese feeding on farmland during winter and spring conflict with agricultural interests along their migratory flyway in north-western Europe. The majority of the geese have abandoned natural feeding sites such as salt marshes and now feed exclusively on nutrient rich agricultural crops. The geese feed in great numbers at high densities and their activity may delay harvest of grass pastures or potentially destroy the crops. In Mid-Norway farmers scare spring-staging pink-footed geese *Anser brachyrhynchus* off their land to protect crops, and this has had clear effects on goose distribution and potential survival during the breeding season. The geese are crucially dependent on the fat reserves they build during the spring season, in order to fulfil the breeding cycle in the high arctic. To protect the geese, Norwegian authorities have implemented economic compensation to farmers to discourage scaring, but this has not been prioritised to accommodate the biological requirements and dispersal patterns of the geese, though such an approach is clearly needed. To address this need, we assessed the negative effects of scaring geese during 2004-2007, and built a species distribution model to identify sites suitable for goose foraging. We subsequently combined known foraging sites with sites identified by our model and prioritised these sites according to their connectivity, perimeter area ratio, years of historic use and proximity to roost.

By combining historic data on foraging sites, a species distribution model, and a simple, accountable site selection process we demonstrate how the current compensation scheme can be made 10 times more efficient through strategic prioritisation. The site selection process will select the most suitable sites for goose foraging, is applicable for all possible sizes of the target area for conservation, and can be implemented by local managers. An example of selected sites out of all the potential suitable sites in the Mid-Norway region is given in fig. 1. Our approach has direct implications for alleviating similar goose-agriculture conflicts throughout Europe. Our results have been well received among the authorities in Mid-Norway, and the implementation of our priority setting in the management of the population will provide an example of conservation in a human dominated landscape.

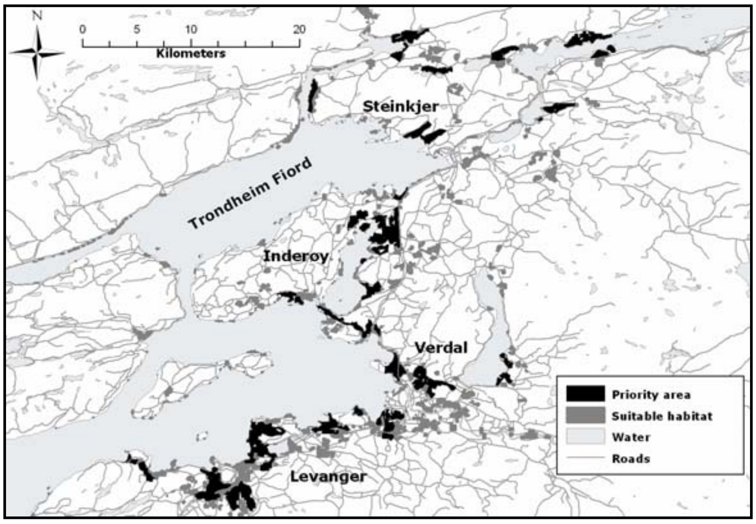

Figure 5 Potential priority area with a target area of 50 km^2.

A new approach for evaluating the success of plant material transfer in flood-meadow restoration

Burmeier, S., Eckstein, R.L., Donath, T.W. & Otte, A.
Institute of Landscape Ecology and Resource Management, Research Centre for Biosystems, Land Use and Nutrition (IFZ), Justus Liebig University Giessen, Germany

Plant material transfer is a technique frequently applied during grassland restoration. Often, however, the availability of species-rich donor material is limited and it is accordingly applied in narrow strips that do not cover the entire target site. It is generally assumed that these strips will act as source populations for the target plant species which will then spread and eventually colonize the entire site. Our aim was to test this assumption. We conducted our study in the floodplain of the northern Upper Rhine where plant material transfer has been applied since the year 2000 within the framework of a large-scale restoration project seeking to re-establish species-rich flood meadows which are then incorporated into local farming management. We selected five plant material strips of 10 m width that had been established in 2000 and 2001 and represent the oldest strips available in the area. On each strip, we established a 2 x 16 m transverse transect starting in the centre of the strip. Each transect was subdivided into eight 2 x 2 m plots, and each plot was subjected to vegetation relevés, seed bank sampling, and seed rain sampling with two different types of seed traps. As a result, we are able to observe colonization at the levels of established vegetation, seed bank, and seed rain. This approach allows for the first time to draw realistic conclusions about the extent and duration of the assumed colonization process, which are indispensable for evaluating the long-term success of the project.

Species viability in dynamic landscapes: Seeking robust spatial-temporal habitat configurations to guide land-use change

Astrid van Teeffelen (1), Claire Vos (2) & Paul Opdam (1,2)
(1) Wageningen University and Research centre (WUR), Department of Environmental Sciences, Land Use Planning group.
(2) Wageningen University and Research centre (WUR), Alterra, Landscape centre.

The quality of landscapes in terms of biodiversity conservation depends on the amount and spatial-temporal arrangement of suitable habitats for species. This quality is not static: natural processes as well as socio-economic activities cause landscapes to be dynamic in space and time. Intensively used landscapes need to fulfill multiple services, like economic development and biodiversity conservation. When space is scarce, the fulfillment of these services can collide in areas desired for development, while being valuable for biodiversity. Conservation through a network of protected areas only, is insufficient in these landscapes with small and scattered protected areas in a matrix of intensely used land, as they lack resilience to disturbances. To obtain resilient ecosystem networks in such landscapes, off-reserve measures for biodiversity conservation are required. Dynamic conservation approaches, such as tradable permits, can be a robust and cost-effective supplement to protected areas if the spatial-temporal habitat dynamics that they create are within acceptable limits for species of conservation concern. While the application of dynamic conservation approaches is on the rise, proper assessment of the impact of land use change on species persistence and ecosystem resilience is limited. In this study, that is part of the ESF project EcoTRADE, we assess what knowledge is required for cost-effective application of dynamic conservation approaches, and we review the literature for available knowledge on species persistence in changing landscapes. Our results indicate that the majority of studies focus on evolutionary questions (e.g. what species properties provide better survival probabilities in changing landscapes), while conservation management requires guidelines about the level and type of dynamics acceptable in intensively used landscapes. Such guidelines are a prerequisite for cost-effective conservation in changing landscapes: Functionally framed in a dynamic conservation approach it facilitates the identification of areas where impact from economic development is minimal, and areas where restoration efforts are expected to return most biodiversity benefit. For a tradable permit market, such information is necessary to be able to design market rules that result in functional, robust ecosystem networks.

Optimizing spatial incentives in tradable permit markets for biodiversity conservation

Florian Hartig, Martin Drechsler
Helmholtz Centre for Environmental Research - UFZ, Department of Ecological Modelling, Permoserstr. 15, 04318 Leipzig, Germany

Markets for environmental services have been proposed as flexible and cost-effective instruments for biodiversity conservation on private lands. In a tradable permit market land users who wish to develop their land need to purchase a permit. Permits are created by land users who improve the ecological value of their land. They can sell these permits to those land users who wish to develop their land, and a permit market emerges.

A prerequisite of a permit market is the establishment of a unique measure of biodiversity value for sites owned by private landowners. Such a measure is required to make sure that biodiversity loss on one site is always compensated for by an equal gain of biodiversity on another site. As average property sizes are much smaller than the scale of typical ecological interactions, the measure can not be based on local site quality only, but will have to take the spatial context (connectivity, fragmentation) into account.

The aim of this study is to analyze how optimal spatial measures (landscape indices) in tradable permit markets are related to ecological parameters such as dispersal of the target species as well as to economic parameters such as behavior and cost heterogeneity of landowners. To do this, we use a coupled ecological-economic model. The economic model is an agent-based model where agents decide to use their land either for economic or conservational purposes and buy and sell permits accordingly. Agents' decisions are affected by the costs of conservation which are spatially heterogeneous and changing in time and by the market value of conservation, determined by the applied landscape indices. By that, a dynamic and spatially heterogeneous land-use pattern emerges. A metapopulation model is placed on top of the economic model, using the emerging landscape as an input. We analyse the combined ecological-economic dynamics and compare the total costs and the metapopulation viability for different landscape indices. Doing so, we can identify the most cost-effective landscape index for a given species and for a given socio-economic setting.

Potentials of compensation pools and compensation agencies for biodiversity – examples from Saxony and Brandenburg

Lars Stratmann (1), Martin Szaramowicz (2)
(1) Leibniz Institute of Ecological and Regional Development (IOER), Weberplatz 1, 01217 Dresden, Germany,
(2) Flächenagentur Brandenburg GmbH; Lennéstraße 75, 14471 Potsdam, Germany

Biodiversity is affected by all kinds of building projects (infrastructure, settlements, etc.). The related negative environmental effects are described by the term "impacts on nature and landscape" in Germany. The German Federal Nature Conservation Act includes a regulation to cope with these impacts ("impact regulation", see [1]). Compensation measures are a main element of this regulation. In contrary to single, dispersed measures that were common practice in the past, compensation pools are a new approach: Compensation measures are bundled either in coherent areas and / or based on regional concepts. These measures must be located in the same planning region or river basin as the impact.

In this context, compensation agencies are a new type of service providers in nature conservation. They develop and broker sites and measures in compensation pools. Equally important is the role of compensation agencies as the central contact and coordination service for investors, authorities and conservationists.

Compensation pools offer new possibilities to realize measures with positive effects on biodiversity. This is shown here on two examples: The pools of the compensation agency (*Flächenagentur*) Brandenburg and pool concepts developed in the project "ReNat", funded by the Deutsche Bundesstiftung Umwelt, in Saxony in the south of Leipzig.

Two main types of pools can be distinguished: In Brandenburg the pools are mainly coherent areas of at least 30 ha. Typically extensive grassland of different types is combined with the initiation of hedgerows, groves and small water bodies. In the more densely populated area south of Leipzig, which is significantly altered by open cast coal mining and where large areas have been consumed by infrastructure and industry in recent years, areas of comparable size like in Brandenburg can hardly be acquired. Thus the pools here consist mainly of connecting elements such as corridors and stepping stones like hedgerows or wildflower strips.

For both types of pools, positive effects on biodiversity have been forecasted and partially monitored in the first years after realization. Nevertheless a lot of specific questions remain open and could be promising fields of cooperation between ecological science and nature conservation practice. Examples are the contribution of compensation pools for biodiversity enhancement and especially the implications of long-term stewardship: As this market-driven instrument includes the obligation as well as the possibility to control its success and - if necessary - to modify measures, appropriate methods for these tasks are needed.

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Striving for conservation targets with tradable permits: Examples from policies in the US and Germany

Silvia Wissel & Frank Wätzold
Helmholtz Centre for Environmental Research – UFZ, Department of Economics; Permoserstrasse 15, 04318 Leipzig, Germany

Tradable permits are an economic instrument to achieve a limitation of resource exploitation cost-effectively. One prominent application for permit markets is CO_2 trading in the European Union to achieve the targets of the Kyoto Protocol where cost savings from trade have been estimated to reach up to 56%.

The advantages of tradable permits, being target oriented, quantity-based and cost-effective while leaving flexibility to market participants make them an attractive instrument also for other environmental problems, such as biodiversity conservation. In biodiversity permit markets or biodiversity offset schemes, developers who destroy ecologically valuable land must compensate by buying permits from others who protect their land for conservation. Such a scheme encourages private land owners to participate in conservation.

However, several prerequisites need to be fulfilled to achieve a successful market result in terms of ecological effectiveness as well as in terms of cost-effectiveness: An ecological target and a measure of conservational value need to be agreed upon. The latter must be enforceable, ecologically sound and still allow for sufficient market activity to balance supply and demand.

To see how such markets can look in practice, we compare the German Impact Mitigation Principle with its flexibilizations for banking ("Flächenpools and Ökokonten") in the federal state of Hessen with the Californian Mitigation Banking. We interviewed stakeholders in both states, including representatives from the public agencies, bankers, policy makers and other interest groups such as farmers or environmental organizations.

By that, we give examples how tradable permit markets for conservation can be designed, highlight the problems which must be handled and show which actors can be involved. We discuss how the regulatory setup determines the incentives for people to participate in the market, invest in conservation and how well economic development objectives can be combined with ecological targets.

Establishing a market-based payment scheme for ecological goods in managed grasslands: a case-study approach

Sebastian Klimek, Anne Richter gen. Kemmermann, Horst-Henning Steinmann
Research Centre for Agriculture and the Environment, University of Göttingen, Am Vogelsang 6, 37075 Göttingen, Germany

Due to lack of appropriate incentives offered by current markets the provision of ecosystem services by farmers is poorly captured. This case-study aimed to correct for this market failure by establishing a regionally-scaled market-based payment scheme for ecosystem services. Payments to farmers were linked to ecological goods representing differently ranked quality-levels of plant diversity that were used as proxies for ecological services derived from managed grasslands. To reward the provision of ecological goods, we designed a market-based payment scheme that comprised a combination of a payment by results approach with an auction mechanism.

In our conceptual framework (Figure 1), farmers are voluntary suppliers of ecological goods. To comply with the lowest ranked ecological good (EG 1), farmers needed to fulfil the requirement of a predefined minimum number of forb species within a grassland site. Higher ranked ecological goods (EG 2 and EG 3) additionally required the occurrence of indictor species. These ecological goods are demanded by society which is represented by a regional advisory board that consist of representatives of government agencies, nature conservation and farmers groups. This regional advisory board works closely together with scientific researchers and decides about the demand of ecological goods. Based on the demand-supply of ecological goods, a market is created by applying competitive biddings in an auction procedure.

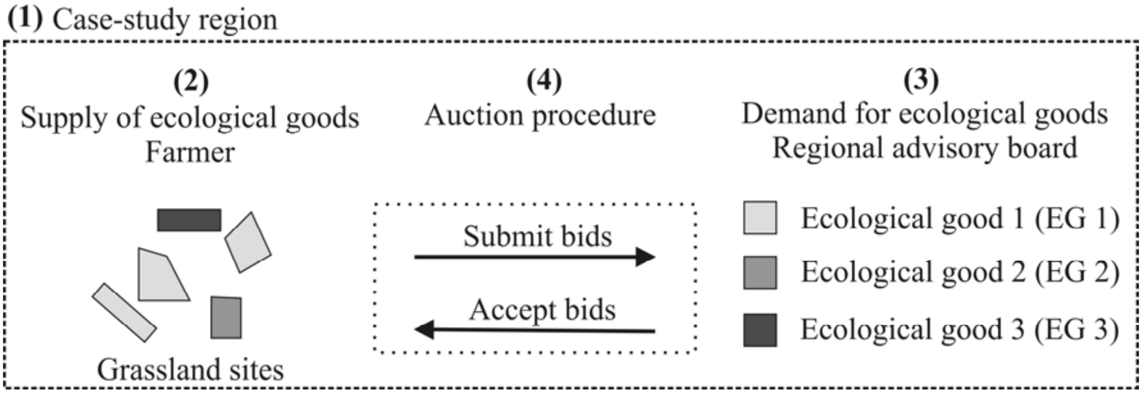

Figure 1: A conceptual framework aimed at rewarding farmers for delivering plant diversity in managed grasslands. Within the regional context of the case-study (1), farmers are supplying ecological goods of grassland plant diversity on their sites (2). These ecological goods represent ecological services derived from grasslands that are demanded by a regional advisory board (3). By applying competitive biddings in an auction procedure (4) for the three different ecological goods, a market is being created.

Our results demonstrated that an appropriately designed payment scheme at a regional scale could support farming systems that are managed for delivering ecological goods in addition to the production of food and fibre. Hence, instead of maximising economic profit through high-input management practices farmers had, for the first time, the possibility to generate income by providing ecological goods of grassland plant diversity.

Valuing ecosystem services – panacea or Pandora's box for biodiversity preservation?

Joachim H. Spangenberg
UFZ – Helmholtz Centre for Environmental Research, Dept. Community Ecology; Theodor-Lieser Str. 4, 06120 Halle, Germany

Scientists employ political and economic arguments to argue for the preservation of biodiversity, and thus the terminology of "ecosystem services" and their economic value. While economic aggregate figures may well serve as alarm bells, raising attention for important ecological issues (and for this function, a significant error margin is no serious problem), they have a downside. The economic terminology has a number of connotations which make its usefulness for the intended effect questionable.

To understand the potential setbacks from monetisation, first the economic thinking behind it is explained: a maximum of welfare is generated by the equilibrium situation of competitive markets, and monetising ecosystem services is a means to make them count in the market process. However, is a competitive market really a safe heaven for biodiversity? If, and only if so, it is market distortion that lead to ecosystem degradation, and internalising the external costs will solve the problem. But is the economic optimum also the environmental one?

Even if this were the case, decisions must be taken how to reach the optimum. In such decision making processes, the equilibrium and thus maximum welfare is reached when the marginal costs equal the benefits, a cost-benefit analysis CBA. But how are costs and benefits determined? Often, the benefit is an economic one, and the costs are environmental damages. In these cases the argument is made that monetising ecosystem services is a necessary step to make them count in decision making processes. But is this a guaranty that biodiversity is preserved? Or is it determining the economically optimal way to biodiversity degradation, as it imposes a one dimensional view, the economic reductionism inherent to monetisation, on ecosystem functions?

Even if CBA is considered a useful tool, the question remains to be answered, how is the value of ecosystems calculated, is that a reliable, reproducible measurement? To answer this question, the methods used and their underlying assumptions are explained and their applicability to ecosystems and their services assessed.

In a first step, this is done for those services representing market goods. Here assumptions about the price mechanism, full information, the future development of value (discounting), the measurement at the margin and the value of stocks are introduced. As a result, it turns out that economic measurement of ecosystem services can cover mainly damage costs in economic systems caused by ecosystem service reduction. The problem gets even more complex when non-market services are included. The main methods and their pros and cons are briefly introduced to illustrate the limits of such evaluations.

Factors Affecting Turkish Adolescents' Commitment to Protect Biodiversity

Sevilay Dervisoglu (1), Susanne Menzel (2), Haluk Soran (1) & Susanne Bögeholz (3 (2)
(1) Hacettepe University, Dpt. of Didactics of Biology, 06800 Beytepe- Ankara, Turkey,
(2) Georg-August-University, Dpt. of Didactics of Biology, Waldweg 26, 37073 Göttingen, Germany
[1]Hacettepe University, Dpt. of Didactics of Biology, 06800 Beytepe-Ankara, Turkey
(3) University of Osnabrück, Dpt. of Didactics of Biology, Barbarastaße. 11, 49076 Osnabrück, Germany

According to Article 13 of the Convention on Biological Diversity, education is a central issue for the protection of biodiversity. Particularly for biodiversity 'hotspots' [1] with locally controlled economic and social threats, the planning of effective educational interventions is of utmost importance. To facilitate evidence-based interventions, we identified factors that affect the commitment of adolescents to protect the rich plant diversity of southern Turkey within the Mediterranean hotspot [2].

Based on the Value-Belief-Norm (VBN) theory [3], our study analyses the behavioral commitment of Turkish adolescents to protect biodiversity. In addition to the constructs of the VBN theory, the influence of problem perception on commitment was investigated based on results of a previous qualitative study [4]. To measure problem perception, we used an additional set of constructs developed by Menzel and Bögeholz [5]. Multiple and simple regressions were carried out to determine the effect of both construct sets on types of behavioral commitment.

'Personal *norms*' were the strongest positive predictor for all measured types of behavioral commitment (R^2= 0.22-0.29). From the *value* constructs, \`universalism\` was the only value relevant to all behavioral commitments. Values explained between 6% and 10% of variance. From the *belief* constructs, 'ascription of responsibility' and 'perceived ability' were relevant for all behavioral commitments. Beliefs explained 17%-18% of variance. *Problem perception* with regard to socio-economic 'factors that contribute to the loss of biodiversity' was more important than the 'perception of ecological threats'. Variables of "problem perception" explained 6%-10% of the variance. According to our results, an encouragement of personal norms seems to be an educational strategy to foster the commitment of Turkish adolescents to protect biodiversity. Biospherical-altruistic value commitments, such as universalism, represent a further promising avenue for educational interventions. Thus, educational interventions should convincingly point out such opportunities.

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Combining inventories and interviews as estimators of biodiversity in the agricultural landscape

Johan Ahnström (1), Jan Bengtsson (1), Åke Berg (2) & Lars Hallgren (3)
(1) Swedish University of Agricultural Sciences, Department of Ecology; Box 7044, 75007, Uppsala, Sweden
(2) Swedish Biodiversity Centre; Box 7007,75007, Uppsala, Sweden
(3) Swedish University of Agricultural Sciences, Department of Urban and Rural Development; Box7012,Uppsala, Sweden

Most research on biodiversity has been aimed at one organism group at the time. Thus, what is studied is not biodiversity as such but the species richness of that particular species group. However, some organism groups are considered to be important indicators e.g. birds and plants, representing the diversity of other organism groups. This approach has been questioned in the literature.

A prerequisite for successful nature conservation is to include the managers of the land, in this case farmers. It is their actions that will affect organisms in the agricultural landscape. Interviews were conducted with 16 farmers regarding their knowledge and interest in nature and nature conservation. Field inventories were done on these farmers' largest winter wheat fields in South Central Sweden. Based on the interviews we have divided the farmers into three categories according to their knowledge about species, interest in nature and nature conservation and their actions taken for the sake of nature conservation. We divided the farmers into fulltime and part time farmers.

Species richness and abundance of birds, bumble bees, solitary bees and wasps, carabids and weeds were studied. Based on the diversity of the five organism groups we constructed a biodiversity measure (BM) . The BM represents the biodiversity of the fields and made it possible to see what variables affect this biodiversity. The independent variables in our analysis were after a selection procedure field area, a measure of landscape heterogeneity, crop density, full- or part time farming and farmers' interest in nature.

The overall BM was significantly related to crop density and farmers categorized as interested in nature. The part time farmers in our study had a more diverse carabid fauna and the abundance of pollinators was greater in fields managed by farmers categorized as interested in nature.

The implications for ecosystem services and nature conservation will be discussed.

Acoustic Ecology: From Landscape to Soundscape

John D. Pantis, Antonios D. Mazaris, Kimon Papadimitriou, Jozeph Tzanopoulos, George Chatzigianidis
Department of Ecology, School of Biology, Aristotle University of Thessaloniki, Greece

Landscapes can be defined as functional ecological spaces were the obtained patterns reflect the interaction between natural processes and human activities. The description of landscape spatial structure and configuration and the detection of landscape changes resulting from the combined effect of natural and anthropogenic processes is usually based on visual attributes. However, landscapes, as complex systems, are also characterized by their sound attributes. The variety of sounds originating from different sources produces the acoustic environment on a landscape which is defined as "soundscape". The appearance of the landscape and its corresponding soundscape, reflect the heterogeneity of the environment and the use of the land in such a way that the uniqueness of the locations are accentuated by the sounds. In this context, the sonic environment can provide an additional level of information on the landscape structure. The aim of this work was to describe the potential perception of the acoustic environment as this is generated by the spatiotemporal variability of different sound signals and is affected by local scaled variables. Our main objectives were to study spatiotemporal variation of the perceived acoustic environment, to identify the dominant sound categories and to investigate the underling mechanisms that lead to acoustical similarities among landscape structures. We further developed a methodology to provide a visualization and mapping of the perceived soundscape and to analyse daily soundscape patterns. We collected acoustic data in a rural area of Greece; the analysed information consists of three general sound categories (Anthopophony, Biophony, Geophony) and seven main sound categories defined according to the origin of sound. In order to study the association between the perceived acoustic environment and landscape attributes, a series of local scaled variables were collected and analysed. Our results show that the great temporal variability of the acoustic environment was mainly reflecting the daily cycle of anthropogenic activities and biological processes while the spatial variability was mainly affected by landscape attributes. Landscape spatial attributes were significantly correlated with the acoustic environment at different sampling periods and for different sampling locations. However, some of those observed patterns did not remain constant in space and time suggesting that the same landscape features may be associated with different acoustic signals and thus increasing the spatio-temporal variation of the soundscape.

Poster presentations

Red List Index as a useful tool for determination of conservation priorities on landscape level

Michal Andreas, Blanka Vlasáková, Dušan Romportl, Alena Míkovcová
The Silva Tarouca Research Institute for Landscape and Ornamental Gardening,
Department of Biodiversity Indicators, Květnové nám. 391, CZ-252 43 Průhonice, Czech Republic

Nowadays, in the period of habitat quality deterioration and species diversity loss, biodiversity conservation and biodiversity hot spots localisation is recognized as an issue of major importance. Biodiversity conservation is a crucial component of conservation policies on many organisational levels Biodiversity of native species is commonly accepted as a measure of habitat value, but the importance of particular habitats as places of endangered species survival should not be omitted. Because a habitat with overall lower biodiversity can still harbour a significant proportion of endangered species we find habitat evaluation using species endangerment status to be an important approach complementary to evaluation of habitats using general biodiversity measures.

Red List of IUCN is widely recognized system for classifying species by the risk of their extinction and Red List Index (RLI) illustrates the relative rate at which a particular set of species changes overall threat status; RLI was applied especially for evaluation of the changes of extinction risk in time for birds and amphibians of different biogeographic realms, birds living in different ecosystems or amphibians of different families (Butchart & al. 2005, Phil. Trans. R. Soc. B). RLI seems to be a useful tool for trend illustration of deterioration or improvement in status.

We used CORINE Land Cover and Natura 2000 mapping systems to obtain basic information regarding habitats distribution and quality in the Czech Republic. The two systems distinguish altogether 171 habitat types that we grouped into 14 units in order to obtain a manageable number of categories. For each habitat we recognized five degradation stages partially based on Natura 2000 mapping system. Species lists of groups widely accepted as important indicators (vascular plants, molluscs, butterflies, ground beetles, amphibians, reptiles and birds) were compiled using expert statements and literature for each habitat. Species were assigned to categories corresponding to their endangerment status in the current Red List of the Czech Republic. To calculate a value of Red List Index, at least two Red Lists from two different periods are usually needed in order to assess the deterioration or improvement of the status in time. We were not interested in the endangerment status changes in time, but in conservation importance of habitats expressed as occurrence of the species with high extinction probability in the habitat. Our RLI was calculated as the difference between the current Red List and a hypothetical one, where all the species were classified as “least concern”. The result is a habitats comparison not only from the view of biodiversity but also from a perspective of their importance as a sanctuary of endangered species.

Complex effects of stochastic events on animal populations: the case of fire on a tortoise population

Rubén Ballestar (1), Andrés Giménez (1), José Daniel Anadón (1,2) & Daniel Oro (3)
(1) Dpto. Biologia Aplicada. Universidad Miguel Hernadez. Avda Universidad s/n, 03202 Elche, Alicante, Spain.
(2) Department of Ecological Modelling, UFZ – Helmholtz Center for Environmental Research, Permosserstr. 45, 04318 Leipzig, Germany
(3) Institut Mediterrani d'Estudis Avançats (IMEDEA), CSIC-UIB, Miquel Marques 21, Esporles, Mallorca 07190 Spain

Stochastic events as fire have complex and heterogeneous consequences over animal populations, especially on reptiles, which are expected to have low ability to respond to disturbance.

This work evaluates the short-term effects of a fire on a protected population of the spur-thighed tortoise (*Testudo graeca*) in south-eastern Spain. For this purpose, survival rates for 3 different age classes of individuals and changes in the use of habitat were estimated using multi-state capture-recapture models and radio-tracking works. Abundance of tortoises was provided for different years using closed-population procedures.

A notable influence of fire on the survivorship of the studied population was observed, mainly on young individuals, which are more vulnerable to external perturbations (decrease from 0’34 to 0’06 and from 0’88 to 0’50 in both youngest cohorts), but also on the adult portion (from 0’97 to 0’82). Global transition rates between both zones increased after the fire (from 0,179 to 0,343), being bigger from outside the burned area to inside it, indicating some preference for the habitat affected by fire. Telemetry analysis provided significant differences when comparing mean perimeter of MCPs (F=6’209; p=0’039; 1d.f.) and the lengths of the trajectories covered (Z=1’676; p=0’07: 1d.f.) for each group. Density estimates indicated an important decrease in population size the punctual year after the catastrophe (32% for adults), with a growing recovery in subsequent years.

Despite of the certain large initial impact of fire on survivorship and population size, a positive effect at the medium term is noticed. The spur-thighed tortoise and some other similar species are known to prefer multi-succesional landscapes, with open shrub-lands and patches of grass, thus improving their isolation ability and the availability of food resources. Other sort or studies (like VPAs) should be developed to explore more complex trends and the effects of fire in the long term.

Distribution patterns and characteristics of plant species in relation to human impact in Cheonju city, South Korea

Il-Ki Choi (1), Eun-Heui Lee (2)
(1) College of Natural Science, Seoul Women's University, Seoul, Korea, berlinchoi@yahoo.co.kr,
(2) Division of Environmental and Life Science, Seoul Women's University, Seoul, Korea, ehlee@swu.ac.kr

Rapid industrialization and urbanization in Korea during the past few decades have led to significant changes in the flora, fauna, ecosystems, and habitats. The present study focuses on Cheonju which is located in southwest Korea and has been recognized as one of the representative cities among many continuously growing cities in Korea. The purpose of this study is to analyze the distribution patterns and characteristics of plant species in Korean urban area in relation to anthropogenic impact. The study examined the elements influencing anthropogenic impact on current flora. And species richness, spectra of life forms, and the performance of non-native species were analyzed in relation to the degree of hemeroby of the biotope types (land-use types). Additionally, distribution of plant species was investigated with regard to land-use types and the definite urban zone.

In order to make a comprehensive survey of all plant species finding in Cheonju, 106 sample plots, each with a size of one hectare, were investigated. These sample plots were selected to represent the typical land-use types within Cheonju and to cover the various distances from the city center. Richness of species, patterns of life forms, and the percentage of non-native species were analyzed in relation to the degree of hemeroby of the sample plots.

The highest species number was found in sites that were moderately influenced. This corresponds to the intermediate disturbance hypothesis. The flora of sites which were subject to the highest level of human impact, was characterized by a high proportion of annual species and non-native species. In the case of Berlin, highest percentages of therophytes as well as non-native species were recorded within those vegetation types, where the intensity of human impact was assessed as being very high. For a clear demonstration of the distribution types of species in Cheonju, some species with similar distribution were selected on the basis of their frequency in the different urban zone. These species were divided into three groups according to similar distribution corresponding to land-use type and urban zone. The three groups of species which were selected for this study correspond to the groups of urban flora by Wittig et al. [1]: urbanophobic, urbanoneutral, and urbanophilus.

[1] Wittig R., Diesing D. & Goedde M. (1985): Urbanophob – urbanoneutral – urbanophil. Das Verhalten der Arten gegenüber dem Lebensraum Stadt. Flora 177: 265-283.

Movements of neotropical understory passerines in fragmented forests of the Brazilian Atlantic Rainforest

Miriam M. Hansbauer & I. Storch
University of Freiburg, Department of Wildlife Ecology and Management, Faculty of Forest and Environmental Sciences, Tennenbacher Str. 4, 79085 Freiburg, Germany

The Mata Atlântica, the coastal rainforest of Brazil is one of the world's 25 biodiversity hotspots and amongst them it is the most highly threatened ecosystem. This region is rich in endemic and threatened animal and plant species, but due to urban development and agriculture, only 7-8 percent of the primary forest still remains.

The objective of our study was to assess how forest fragmentation and landscape features affect the movements of different Atlantic forest bird species. Movement behaviour is one of the keys to understanding the ecology of animal populations in fragmented landscapes, because there, species persistence is generally dependent on gene flow and metapopulation connectivity. In this context, edges of forest patches are an important feature, because they are characterized by abiotic factors and ecological processes distinctly different from those in the original forest. Thus, the actual forest area is reduced and the edge zone might be a first barrier for dispersing individuals. Accordingly, we also looked at fine scale movement patterns for a better understanding of the spatial ecology of animals towards forest edges.

We conducted the field work on the Atlantic Plateau of São Paulo, in the district of Caucaia do Alto (23°35´S, 23°50´S and 46°45´W, 47°15´W), where we captured and radio-tracked the birds in five fragments (3 ha - 53 ha) and in an adjacent control area – a natural reserve of 10, 000 ha. The three study species were the Blue Manakin (*Chiroxiphia caudata*, Pipridae), the White-shouldered Fire-eye (*Pyriglena leucoptera*, Thamnophilidae) and the Rufous-breasted Leaftosser (*Sclerurus scansor*, Furnariidae). *C. caudata* is mostly frugivorous, whereas the two other species are insectivores. All three species are exclusively forest dwelling. Via triangulation daily positions and daily movements of tagged individuals were documented for a period of three to five weeks.

The most strictly forest species *C. caudata* and *S. scansor* avoided forest edges, while *P. leucoptera* showed affinities to the edge. Both sensitive species showed larger mean step lengths and maximal observed daily distances in the fragmented forest versus the unfragmented forest. *P. leucoptera* did not show any significant difference. Our results suggested that fragmentation and the consequent increase in edge areas do influence movement behaviour of sensitive forest understory birds that avoided the use of edges and increased the speed and distance they covered daily.

However, by comparing our data with the results of other studies on the same species (e.g., [1]), we concluded that movement behaviour of resident birds differs from that of dispersing birds and might not allow to infer functional connectivity or landscape-scale sensitivity to fragmentation; a fact that should be taken into consideration when suggesting conservation strategies.

[1] Uezu, A., Metzger, J.P., Vielliard, J.M.E., 2005. Effects of structural and functional connectivity and patch size on the abundance of seven Atlantic Forest bird species. Biological Conservation 123, 507–519.

Biodiversity and land use of coastal habitats of the Baltic Sea

Jasmin Lendzion (1), Jens Schirmel (2), Astrid Köppler (1), Irmgard Blindow (2), Ulrich Hampicke (1) & Stefan Zerbe (1)
(1) University of Greifswald, Institute of Botany and Landscape Ecology, Grimmer Str. 88, 17487 Greifswald, Germany
(2) University of Greifswald, Biological station Hiddensee, Biologenweg 15, 18565 Kloster/Hiddensee, Germany

Coastal brackish grasslands and coastal heathlands of the Baltic Sea are the result of age-long livestock grazing and are characterized by a high biodiversity. According to global change both habitats are endangered now. Changes of management, abandonment of traditional livestock grazing, infrastructure development and eutrophication have led to an alarming decline of both habitats. To save coastal habitats in a changing world, it is import to know which management schemes are economically tolerable and which management will lead to high biodiversity and to living spaces for endangered species.

Our project analyses the effect of different management schemes on the biodiversity of plants and insects in coastal brackish grassland and coastal heathlands of Mecklenburg-Western Pomerania, Germany. We selected the following management schemes: a) extensive grazing with cattle or sheep, b) intensive grazing with cattle or sheep, c) mowing, d) mowing and livestock grazing in rotation. The project further evaluates the costs and the gains of each management scheme, and investigates the effects of abandonment of management for each habitat. With the information gained by our project, we hope to evaluate management strategies to save these unique ecosystems.

The role of traditional farming in the conservation at the top-level of the ecosystem: trashumance and scavengers.

Patricia Mateo-Tomás (1) and Pedro P. Olea (2)
(1) Department of Biodiversity and Environmental Management, Faculty of Biological and Environmental Sciences, University of León. Campus de Vegazana, E-24071, León, Spain.
(2) Department of Exact Sciences and Environmental Biology, Faculty of Experimental Sciences, IE University, Campus Santa Cruz la Real, E-40003, Segovia, Spain.

The seasonal livestock movements between winter pastures in low regions and summer pastures in mountain areas (trashumant activity) are a decreasing traditional practise with noticeable importance in biodiversity conservation. This influence of trashumance on ecosystems has been mainly studied in plants and arthropods but not in vertebrates. We analysed the transhumant activity of sheeps and cows in the Cordillera Cantábrica, NW Spain, and its influence on the spatial and temporal distribution of Griffon Vulture (*Gyps fulvus*), a highly representative species of the guild of scavengers and a relevant functional piece in these mountain ecosystems. Results revealed a strong spatiotemporal adjustment in the use of these mountain areas by sheeps, but not cows, and vultures. Trashumant flocks of sheep arrived in May and left the area at middle October, with the maximun number reached between 15 July and 15 August. The same pattern was observed for vultures in the two consecutive years studied, highlighting that trashumance may be of major importance in the conservation of ecosystems not only through influence at the bottom of the food chain (i.e.vegetation) but also through influence at the top (scavengers). Trashumance could thus aid in the conservation of Griffon Vulture populations in a sustainable way. This seminatural system strongly contrasts with that of eastern Spain where large vulture populations are artificially dependent on feeding stations supplied by intensive farming, with emergent conservation problems for vultures derived from new sanitary laws. The potential impact that the ongoing lost of the trashumant activity would have on the conservation of mountain ecosystems and especially of the globally threatened vultures should be taken into account, mainly in Mediterranean countries, holding the largest vultures populations in Europe. The maintenance of this traditional activity with such an important role in biodiversity conservation should be considered by the new Common Agricultural Policy of the EU.

Is the decline of the house sparrow caused by reduced farmland heterogeneity?

Maria von Post, Ola Olsson & Henrik G. Smith
Lund University; Ecology building, 223 62 Lund, Sweden

Swedish farmland bird populations have declined for decades [1], reflecting similar trends throughout northern Europe [2]. These declines have been attributed to agricultural intensification [3]. The house sparrow, *Passer domesticus*, is one of the most affected species, and has declined by more than 50 % in Sweden during the last decades [1]. It is a non-migratory bird, feeding on seeds and weed except during the breeding season when they feed their nestlings mostly insects. The house sparrow is strongly connected to the human community resulting in dependency on food resources and nesting cavities, non-purposely created by humans [4]. The change in farming and building techniques, pesticide use, landscape changes, and several other aspects connected to our cultural development during the last decades has had an immediate effect on the house sparrows ability to thrive. The population decline occurs in both urban and rural habitats but probably due to different causes [5]. This study will focus on the decline in the agricultural landscape and the causes connected to this habitat.

During this spring, 2008, an inventory study is being performed in the farmland of Scania. Farms in areas with different intensification of agriculture and different activities (crop/animal husbandry/mixed farming) are being investigated to determine presence and density of house sparrows as well as other farm yard connected bird species. Approximately 200 farms will be visited during this inventory. We are expecting to find a higher density of house sparrows and higher species richness on farms in areas with higher heterogeneity (less intensification) and mixed farming than on farms in areas with high specialisation and intensification.

Further on we are planning to establish colonies of house sparrows on farms with different values of heterogeneity. We will monitor these colonies and collect data on breeding success, biometry, plants and insects, video monitoring, radio tracking, perform food-restriction experiments and blood sampling (genetically determination of population structure) to try to get a good picture of all the aspects that could influence a population decline. We will report results from the first field season.

[1] Lindström, Å & Svensson, S. Övervakning av fåglars populationsutveckling. 2006. Lund, Sweden, Dept. Ecology, Lund University.
[2] Donald, P.F. *et al.* Further evidence of continent-wide impacts of agricultural intensification on European farmland birds, 1990-2000. *Agric. Ecosyst. Environ.* 116, 189-196 (2006).
[3] Donald, P.F., Green, R.E. & Heath, M.F. Agricultural intensification and the collapse of Europe's farmland bird populations. *Proc. R. Soc. Lond. B* 268, 25-29 (2001).
[4] Vincent, K.E. Investigating the causes of the decline of the urban house sparrow *Passer domesticus* population in Britain. 2005. De Mountford Univ.
[5] Robinson, R. A., Siriwardena, G. M. & Crick, H. Q. P. Size and trends of the house sparrow *Passer domesticus* population in Great Britain. *Ibis* 147, 552-562 (2005).

People, land-use and climate: factors driving raptor richness in the sahel

José Antonio Sánchez-Zapata (1), José Daniel Anadón (1), José Antonio Donázar (2), Martina Carrete (2), Fernandi Hiraldo (2)
(1) Miguel Hernández University
(2) EBD, CSIC

In the present work we explore the relationships between raptor species-richness and the presence of human settlements, habitat and productivity in the Sahel, a region in which many European trans-Saharan migrant birds winter. The study was conducted in the western Sahel, mostly in eastern and southern Mauritania and, to a lesser extent, in central Mali and northern Senegal. We conducted road censuses of raptors in two consecutive winters. The relationships between raptor species-richness and human population, productivity and habitat were explored by means of GLMs. Because of the high proportion of zeros in the data set, we employed zero-inflated Poisson models.

A deviance partitioning analysis showed that all three factors have a similar influence on raptor richness patterns. Raptor richness was negatively related to small and nomadic human settlements, but positively related to larger human settlements such as villages or towns. Our results imply that the relationship between species richness and human population may depend not only on human density per se, but also on its spatial arrangement and its interaction with habitat and productivity. We discuss the results with reference to increases in human population and changes in land-use and climate, the main environmental changes currently facing the Sahel and also currently the main components of global change.

Potentials of compensation pools and compensation agencies for biodiversity – examples from Saxony and Brandenburg

Lars Stratmann (1), Martin Szaramowicz (2)
(1) Leibniz Institute of Ecological and Regional Development (IOER), Weberplatz 1, 01217 Dresden, Germany,
(2) Flächenagentur Brandenburg GmbH; Lennéstraße 75, 14471 Potsdam, Germany

Biodiversity is affected by all kinds of building projects (infrastructure, settlements, etc.). The related negative environmental effects are described by the term "impacts on nature and landscape" in Germany. The German Federal Nature Conservation Act includes a regulation to cope with these impacts. Compensation measures are a main element of this regulation. In contrary to single, dispersed measures that were common practice in the past, compensation pools are a new approach: Compensation measures are bundled either in coherent areas and / or based on regional concepts. These measures must be located in the same planning region or river basin as the impact.

Compensation pools offer new possibilities to realize measures with positive effects on biodiversity. This is shown here on two examples: The pools of the compensation agency (*Flächenagentur*) Brandenburg and pool concepts developed in the project "ReNat", funded by the Deutsche Bundesstiftung Umwelt, in Saxony in the south of Leipzig.

The 2010 target and beyond – Challenges for conservation biology and policy

6.3. Development and implementation of modern approaches to biodiversity conservation

Katrin Vohland, Zita Izakovičová

Oral presentations

Multiple-species conservation planning in Europe: Quantifying area requirements

Kerstin Jantke (1,2) & Uwe A. Schneider (1,2)
(1) University of Hamburg, Research Unit Sustainability and Global Change; Bundesstrasse 55, 20146 Hamburg, Germany
(2) International Max Planck Research School on Earth System Modelling, Max Planck Institute for Meteorology; Bundesstrasse 53, 20146 Hamburg, Germany

Protected areas in the European Union cover currently about 20 percent of the total land area. Reservation has often been done ad hoc and uncoordinated between countries, and despite increasing conservation efforts, biodiversity loss is still accelerating. Considering land scarcity and demand for alternative uses, efficiency in conservation strongly depends on the efficiency in land allocation.

Our research question are:

- How efficient in terms of area requirement are different strategies of cooperation in conservation planning?
- What impact does comprehensive spatial cooperation in conservation planning have on the overall area requirement?

Systematic conservation planning provides tools to identify optimally located priority areas for conservation. The objective of the minimum-set problem is to minimize resources expended, subject to the constraint that all biodiversity features meet their conservation objectives. We employ a deterministic, spatially explicit mathematical optimization model programmed in general algebraic modelling system (GAMS).

The model allocates species habitats by minimizing the total area for setting aside land for conservation purposes. Constraints ensure that all included biodiversity features reach their conservation objectives. These objectives account for the two principal conditions of systematic conservation planning: representation and persistence of the biodiversity features. Each species has to reach a given representation target in locations where it occurs, meet its area requirements for viable populations, and be allocated to its necessary habitat types. Mixed integer programming (MIP) is used to represent minimum habitat area thresholds for all included species.

We apply the problem to European wetland species. 69 vertebrate species listed in the annexes of the birds and the habitats directive serve as surrogates for biodiversity. Modelled scenarios include for example systematic, biogeographical, and political cooperation in conservation planning.

The model estimates area requirements for habitat protection for stepwise increasing conservation targets and different scenarios of cooperation. Our approach illustrates and quantifies the efficiency of multi-species versus single-species conservation activities.

Resilience maintaining regulation of populations featuring a buffer structure to reconcile conflicts between conservation and economics

Sten Zeibig (1), Karin Frank (1)
(1) Helmholtz Centre for Environmental Research – UFZ; Permoserstraße 15, 04318 Leipzig, Germany

Ecological-economic conflicts arise when a protected species develops such large population sizes, that markable economic losses caused by the species are to be deplored. To reconcile such a conflict population size may be regulated. But, this can be resource waisting or even dangerous for the survival of the population, if it features a buffer structure, which is able to resist regulation attempts to a certain degree. The buffer structure considered here is mainly build by mature but not reproductively active individuals. These individuals are able to fill vacancies in the reproductive part of the population and thus can buffer losses among reproducing individuals. Starting with the case study of the conflict between fishery and conservation of the Great Cormorant (Phalacrocorax carbo sinensis) in Europe, the widespread buffer structure of populations is conceptualized by a stochastic simulation model. The model is used to explore the ecological effectivity and efficiency of different types of regulation strategies. It consists of two parts: the part of reproductive individuals and the reproductively inactive buffer individuals. The interchange mechanism of individuals between the two parts is modeled dependent on the size of the reproductive part. For regulation threshold strategies are applied. The definition of these strategies contain a threshold for population size, below which no regulation takes place. Five types of regulation strategies are investigated: They affect either the size of the reproductive part of the stock, size of the buffer, size of both parts, the reproduction rate or the environmental capacity of the reproductive part. Strategies are applied to buffers with different characteristics. It turns out, that the buffer is a resilience mechanism, which can easily be destroyed by reducing the size of the reproductive part. This destruction of resilience, and thus the increase of extinction risk, is not gradually but happens abrupt above a certain threshold and intensity of regulation. The point of resilience loss depends of the characteristics of populations buffer structure. Two of the alternative regulation types, manipulating the buffer size or the reproduction rate, are plainly ineffective. Reducing both parts, reproductives and buffer, can be effective to a limited degree. Buffer characteristics can have strong influences on ecological effectivity and efficiency of these strategies. Reducing the environmental capacity of the reproductive part works for most of the investigated scenarios, because this strategy conserves the structure of the population. These results have strong implications to reconciliation strategies for conflicts as the one about the Great Cormorant. The standard approach of reducing population size directly (mostly by culling) tends to be either ineffective or risky, in terms of population extinction. By reducing both the reproductive part and the buffer part with same intensity a limited range of regulation targets can be achieved. This shows that for the standard strategy (culling individuals) the mostly normative decision about the desired regulation target can not be taken arbitrarily but is bounded by the properties of the population structure. This holds, if the capacity of the reproductive part can not be reduced. If capacity of the reproductive part can be reduced, a broad range of targets can be achieved by this. Beyond these results this model study shows the importance of the understanding **abstract too long/cut**

Concepts of Ecosystem, Geosystem and Geoecosystem in ecology: implementation to biodiversity conservation

P. Elias
Dept. of Ecology, Slovak Agricultural University in Nitra

Concept of Ecosystem, introduced and developed by A.G. Tansley, have been used as an usefull theoretical basis for modern nature and biodiversity conservation. Ecosystem approach in CBD implementation and Ecosystem management in natural resources management are developed. In geographical sciences another concept – a geosystem – was introduced (V.B. Socava) and a geosystemic approach to landscape research was developed. And (in last years) the last approach have been suggested in nature conservation as a possible alternative to ecosystem approach. (Bio)geographical concepts of ecoregion and/or geo-ecosystem are preferred in large (global) scale approaches to biodiversity conservation. The paper will critically discuss the concepts, three different theoretical and methodical approaches to and their application in nature conservation.

Landscape dynamic supports biodiversity: Implications for urban planning and conservation management

Mira Kattwinkel Robert Biedermann , Michael Kleyer
University of Oldenburg, Institute of Landscape Ecology; Carl von Ossietzky Str. 9-11, 26129 Oldenburg, Germany

Today, about half of the world's and more than 70 % of the European population live in urban areas and ongoing urbanisation requires an increasing amount of land and other resources. However, in spite of the threats urbanisation imposes on biodiversity, cities are generally species rich and their green spaces can offer habitat for rare and endangered species. In contrast to rather static parks or gardens, open spaces like derelict sites, previously-developed land, abandoned railway tracks, or landfills are dynamic in space - as their locations shift due to redevelopment and abandonment - and time - due to continuous changes through the course of succession. These two processes result in a spatio-temporal mosaic of patches of different successional stages, and built-up areas.

The importance of the spatial as well as the temporal structure of habitat patches for urban biodiversity has been recognised, but rarely quantified. We developed a modelling shell to analyse species responses to environmental parameters and to the spatio-temporal configuration of urban habitats in a multi-species approach (38 plant and 43 insect species). The shell comprises scenario development, calculation of species occurrences by species distribution models, and evaluation of the modelling results from the conservational perspective.

Application of the modelling shell to industrial areas in Bremen (Germany) revealed that most modelled plant, grasshopper, and leafhopper species could be maintained at a proportion of open sites of at least 40 % and an intermediate turnover rate (mean site age of 10 to 15 years).

Landscape dynamic, resulting in a shifting mosaic of habitats of different successional stages, supports urban biodiversity and should be incorporate into urban conservation planning. It is necessary to allow for a 'temporary conservation' in urban areas, which, in contrast to common practice in traditional nature conservation, excludes only some areas from development at a time while accepting the destruction of habitat at one place for creation of new habitat at another. This approach solves the conflicts between the economical need for (re-)development and conservation interests.

Developing Adaptive Institutional Regimes for Wetland Management and Biodiversity Conservation

Pablo F. Méndez (1), Jaime Amezaga (2), Luis Santamaría (1)
(1) Laboratory of Spatial Ecology, Mediterranean Institute for Advanced Studies (CSIC-UIB), Miquel Marqués 21, 07190 Esporles, Mallorca, Spain
(2) SWAN Institute, Devonshire Building, Newcastle University, Newcastle upon Tyne, NE1 7RU, United Kingdom

Traditional management regimes for ecosystem management and biodiversity conservation have been characterized by unique-target, control-based strategies consolidated by rigid institutional arrangements and organizational structures. This has resulted in a frozen, endless policy making processes that repetitively attempt at domesticating nature and simplifying management operations, in order to avoid fluctuations and reduce uncertainty. The failures and limitations of these regimes have resulted in a worldwide acknowledgement that successful management must rest in the strategic design of continual, dynamic and proactive programs – such as those based on adaptive management (AM hereafter).

The AM perspective is rooted in the development of a suite of interrelated concepts and heuristics based on complexity-theory, such as ecological resilience, adaptive capacity, complex adaptive systems and adaptive cycle. It has been posed as a feasible alternative to current management strategies, as it adds a new dimension to the policy making process. It constitutes a rational, logic alternative because (i) its intrinsic structure of iterative learning loops explicitly allows for a continuous incorporation of empirical knowledge, based on management practice, into theory, (ii) it allows for new, science-based policies, i.e. it envisages policies as alternative hypotheses to be tested, and (iii) it fosters creative theoretical development, hence innovative methodologies that, in turn, allow for the improvement of the role of science, objective management programs implementation, and better scenario developments.

However, AM may be constrained by several barriers in the social-political arena, such as rigidities in the institutional regime on the ground. We use a case study from the Doñana Nature and Biosphere Reserve (Guadalquivir Estuary, SW Spain) to describe how an AM-based strategic design is fostering the emergence of an Adaptive Institutional Regime (AIR). Such AIR involves the development of new institutions and paradigms for (i) anticipating surprise and sudden collapse through adaptive strategies, (ii) making policies and taking decisions collectively, democratically, and based on updated information and knowledge, (iii) learning from every operation made on the ground at the management level, and (iv) fully consider the diversity of stakeholder interests, values, beliefs and perceptions.

We also use this example to discuss synergies with WFD requirements and goals regarding stakeholder involvement and public participation, and (good) ecological status.

Poster presentations

BEN – Biodiversity and Ecology in National Parks

Irmgard Blindow (1), Martin Diekmann (2), Cynthia Erb (3), Ulrich Hampicke (4), Veit Hennig (3), Maike Isermann (2), Kai Jensen (5), Anna Jürgens (6), Astrid Köppler (4), Ingo Kowarik (6), Jasmin Lendzion (4), Jens Schirmel (1), Martin Stock (7), Antonia Wanner (5), Stefan Zerbe (4)
(1) Biological station Hiddensee, University of Greifswald, Biologenweg 15, 18565 Kloster/Hiddensee, Germany
(2) Vegetation Ecology and Conservation Biology, Bremen University, Leobener Strasse, 28359 Bremen, Germany
(3) Animal Ecology and Conservation, Biocentre Grindel, Hamburg University, Martin-Luther-King Platz 3, 20146 Hamburg, Germany
(4) Institute of Botany and Landscape Ecology, University of Greifswald, Grimmer Strasse 88, 17487 Greifswald, Germany
(5) Applied Plant Ecology, Biocentre Klein Flottbek, Hamburg University, Ohnhorststrasse 18, 22609 Hamburg, Germany
(6) Ecosystem Science and Plant Ecology, TU Berlin, Rothenburgstrasse 12, 12165 Berlin, Germany
(7) Landesamt für den Nationalpark Schleswig-Holsteinisches Wattenmeer, Schloßgarten 1, 25832 Tönning, Germany

Coastal areas are worldwide among the most dynamic and sensitive ecosystems with high conservation value. Five German National Parks include coastal areas along the North and the Baltic Sea. Studies on the relationships between biodiversity and different types of land use in terrestrial coastal ecosystems form the basis to develop sustainable management strategies aiming at maintaining biodiversity.

Therefore, three Junior Research groups on ecology and biodiversity of these areas are funded by the Bauer-Hollmann Foundation and Rudolf and Helene Glaser-Foundation under the roof of the Donors' Association for the Promotion of Sciences and Humanities in Germany (Stifterverband für die Deutsche Wissenschaft) between 2008 and 2011.The first BEN project, dealing with coastal areas, is composed of three Junior Research groups:

1) Biodiversity, management and ecosystem functioning of saltmarshes in the National Park Schleswig-Hosteinisches Wattenmeer (BASSIA). Effects of land use changes on the biodiversity of vegetation and nesting birds as well as on ecosystem functions (sedimentation and balance of silica) are studied, aiming at the development of recommendations to optimize salt marsh management in the National Park (Antonia Wanner, Cynthia Erb, Veit Henning, Kai Jensen, Hamburg & Martin Stock, Tönning).

2) Biodiversity and land use of coastal habitats of the Baltic Sea. Analysed are the effects of different management schemes (grazing, mowing) on the biodiversity of plants and insects in coastal brackish grassland and coastal heathlands of Mecklenburg-Western Pomerania, Germany. Furthermore, an evaluation of the costs and the gains of each management scheme are included. (Jasmin Lendzion, Ulrich Hampicke, Astrid Köppler, Stefan Zerbe, Greifswald & Irmgard Blindow, Jens Schirmel, Hiddensee).

3) Biological invasions, regional identity and biodiversity. The example of *Rosa rugosa*. Biological invasions are a major threat for biodiversity, which concerns diversity of genes, species, communities, ecosystems, as well as of the landscape. Using *Rosa rugosa* the project will exemplify, how a differentiate analysis of species invasion potential in relation to various dune habitats along the German North Sea and different entities, could be used for the development of nature conservation strategies.

Taxonomy and partners in science

Daphne Duin (1), Jutta Eymann (2), Christoph Häuser (2), Gaël Lancelot (1), Juan Carlos Monje (2), Simon Tillier (1)
(1) Muséum National d'Histoire Naturelle CP 43, 57, rue Cuvier 75231 Paris, France
(2) State Museum for Natural History Stuttgart, Rosenstein 1, 70191 Stuttgart, Germany
EDIT - http://www.e-taxonomy.eu/

Science is not produced by scientists in a vacuum. This is the rationale behind several activities in the European Distributed Institute of Taxonomy (EDIT), a network of 27 natural history institutions and organisations. EDIT is established to get taxonomy ready to respond to future needs and demands in biodiversity and ecosystem research. The central objectives set by the network are to promote an integrated science by reducing fragmentation in taxonomic work processes and to strengthen the scientific, technological and information capacities needed for taxonomy and biodiversity research in general. Hence, the EDIT work program targets both scientific activities of taxonomists *and* activities of its social partners. To create the most favorable environment for taxonomy, an elaborate network of partners in science is necessary, partners that support, facilitate and make taxonomy and its products and services accessible and visible to everyone who needs it.

Everyone who uses taxonomy or who comes into contact with it is a possible partner. This makes the list of potential affiliations between taxonomy and partners almost infinite. Concrete examples of taxonomic stakeholders include: the general public (nature lovers and anyone using vernacular or scientific names); taxonomic facilitators (funding bodies, educational facilitators, developers of research tools, taxonomic information facilities etc); scientific users of taxonomic knowledge (professional and amateur taxonomists, agriculture, archeology, conservation science, ecologists, environmental studies, genomics, genetics, molecular sciences, medicine etc.); professional users (conservation management, environmental assessment industry, custom services, pest management, cosmetic and pharmaceutical industry, national governments, international governance bodies etc.); and partner networks and projects in taxonomy and biodiversity science. We must better liaise these stakeholders with taxonomists and inform the stakeholders on what taxonomy is and how it can help them to understand the natural world or how to use it to their own advantage.

Stakeholder activities within EDIT aim to create awareness of the diversity of stakeholder needs and the potential of partnerships. EDIT offers an environment where taxonomists and stakeholders can meet, where they can experiment with joint research and outreach activities and, if proven successful, where a Memorandum of Understanding (MoU) can be signed to formalise future collaboration. Current stakeholder activities include public awareness and communication activities on taxonomy towards the general public, the scientific community, professional user communities and to others networks and projects in biodiversity research and policy. Several workshops with taxonomists and other stakeholders are planned for 2008 and 2009, partnerships between EDIT and other biodiversity networks already have proved fruitful, and MoU’s for All Taxa Biodiversity Inventories and Monitoring (ATBI+M) efforts are signed with protected areas in France, Italy, Slovakia and Tanzania (see contribution by Häuser et al. in this volume).

Taxonomic Expertise for Biodiversity Inventories and Monitoring of Conservation Areas: The EDIT ATBI+M approach

Christoph L. Häuser , Juan Carlos Monje & Jutta Eymann
Staatliches Museum für Naturkunde Stuttgart, Rosenstein 1, 70191 Stuttgart

The "European Distributed Institute of Taxonomy" (EDIT) is an initiative of 27 European, North American and Russian institutions to build a network in "Taxonomy for Biodiversity and Ecosystem Research" (www.e-taxonomy.eu). European Commission (EC) funding (Sixth Framework Programme, FP6) for this "Network of Excellence" has started in March 2006, and is expected to last for 5 years.

EDIT's objectives are to reduce the fragmentation in European taxonomic research and expertise through institutional integration, thereby improving society's capacity for biodiversity conservation. For Work Package 7 (WP 7) "Applying Taxonomy to Conservation" the aim is to strengthen the input of taxonomic expertise in Europe for biodiversity conservation, by organising the participation of individual taxonomists and experts in biodiversity inventory and monitoring efforts in conservation areas (www.atbi.eu).

The mechanism for achieving this objective is the establishment of "All Taxa Biodiversity Inventories" (ATBI) "+ Monitoring" (+M) sites in selected protected areas. ATBI+M tasks are intensive, large-scale efforts to record, identify, and document the entire biodiversity of a given area, with as efficient as possible methods. EDIT's ATBI+M sites are different from traditional approaches in their longer-term orientation: from an initial species inventory, they will form the basis for monitoring biodiversity changes over time.

EDIT WP7 organizes and supports teams of taxonomic experts for inventory and monitoring field work at designated ATBI+M pilot sites. Active European ATBI+M sites are located in the Mercantour & Alpi Marittime Natural Parks (France / Italy), and in three protected areas in the Gemer region (Slovakia). For the first area, already more than 1.500 species have been recorded by 50 scientists from 10 EU countries during 2007. The data generated by EDIT's ATBI+Ms will also become accessible world-wide through the Global Biodiversity Information Facility (GBIF). The first ATBI+M sites outside Europe (Tanzania: Udzungwa Mountains N.P., Ecuador: Loja) will soon become operational in addition to further European sites over the next years, and additional participants will be welcome.

Individual identification from wild boar (*Sus scrofa*) faeces to estimate population size

K. Kolodziej (1), H.K. Schulz (1), C. Ebert (2), U. Hohmann (2), D. Huckschlag (2) & R. Schulz (1)
(1) University of Koblenz-Landau, Institute of Environmental Sciences, Fortstr. 7, 76829 Landau,Germany
(2) Research Institute of Forest Ecology and Forestry, Schloßstr.16, 67705 Trippstadt, Germany

The growing wild boar population during the past three decades lead to increasing problems in agricultural areas and play a significant role as disease reservoir in Germany. For an effective population management population size information is of crucial importance. Non-invasive genetic methods are a promising complement to traditional methods for population size estimation. These methods reduce stress and capture bias and increase the number of observations. Faeces proved to be a suitable DNA source for wild boar genotyping, however working with faeces-DNA implicates difficulties such as low DNA quality and quantity, genotyping errors as dropout and false alleles. Our aim was to develop a reliable, cost-efficient and practicable method for wild boar genotyping. Individual identification forms the basis for an adapted mark-recapture approach. In order to achieve the best possible amplification success rate and genotyping results we optimized storage and extraction methods and PCR-procedure. We will present first results of a wild boar population census in a 4000 ha study area in Rhineland-Palatinate in Germany. We collected 141 faecal samples during a two week period in winter 2006. Individual genotyping was based on a set of six microsatellite markers which proved to be polymorphic and wild boar specific. To reduce genotyping error rates we applied multi-tubes approach and post-amplification checking and correction procedures. From the 141 samples 86 could be analyzed and 76 individuals were identified. An estimation of 426 individuals in the study area was calculated. The impact of genotyping error to estimation results will be discussed.

Marine pollution impact on foraminfieral biodiversity of Pulicat lake, east coast of India

Jayaraju Nadimikeri
Department of Geoinformatics, Yogi Vemana University, KADAPA- 516 003, India E-mail :
nadimikeri@gmail.com

Coastal uses and other anthropogenic activities have inevitably impinged on the marine environment. Therefore these regions require constant monitoring. Although Sea covers over 70% of the surface of land, the coasts are the most vital as for as human activities are concerned since it is the key source of living marine resources used as food for human and it is almost significantly impacted by anthropogenic factors. The out put of anthropogenic contaminants as a result of domestic, industrial and agricultural human activities. The need to detect and assess the impact of pollution has prompted the development of biomarkers. The east coast of India is an ideal place to study marine pollution. Benthic foraminiferal studies provide the potential for a quick ,cost effective method of assessing the impact of pollution on the biota for monitoring change and for comparing the modern fauna with that of the unpolluted past. Study of foraminiferal diversity and distributional patterns also provides an efficient method of investing the role and impact of anthropogenic activities on the study area. Knowledge of the ecology of recent benthic foraminifera has application both in modern and past environmental studies. In this study attempt was made to decipher the biodiversity of benthic foraminifera owing to the anthropogenic pollution from lake Pulicat. To realize this objective a total of 30 sediment samples were studies which were collected from the lake . Out of 45 species recorded ,only 35 have living representatives while the rest occurred as dead. The prominent species in deceasing order are *Ammonia beccarii, Elphidium hispidulum , Quinqueloculina agglutinans, Elphididum excavatum* and *Quinqueloculina oblong.* This shows , how ever, that the living representatives have very limited diversity rather than distribution. Probably, the pollution might have adversely affected biodiversity of the fauna in lake Pulicat . Realizing the foraminiferal proxies such as the present one ,low diversity , efforts were made to characterize the specific types of foraminiferal species to the specific pollution. It was at this stage the need for culture studies was widely felt which results in numerous lab and field cultures studies where foramanifers were subjected to specific pollutants in order to document their response to these pollutants and to develop effective foraminiferal proxies for pollution monitoring through time.

Method and results of evaluating management effectiveness of small-scale protected areas in the Czech Republic

Martin Svátek
Mendel University of Agriculture and Forestry; Zemedelska 3, 613 00 Brno, Czech Republic
msvatek@centrum.cz

In 2004, the seventh Conference of the Parties to the Convention on Biological Diversity endorsed a programme of work on protected areas which included the following activities: to develop and adopt, by 2006, appropriate methods for evaluating the effectiveness of protected area management (goal 4.2.1); and to implement management effectiveness evaluations of at least 30% of each Party's protected areas by 2010 (goal 4.2.2) [1]. The following eighth Conference in 2006 recognized that still no methodology of protected area management effectiveness exists [2].

In this paper, our own methodology and preliminary results of the first ever evaluation of protected areas in the Czech Republic are presented. The method for evaluating the state and management of small-scale protected areas has been applied in more than 150 areas in the Czech Republic. The most common management weaknesses and strengths were identified. Results of the evaluation not only highlighted the key issues of single areas, but also provided overall up-to-date information on whole networks of protected areas in different regions of the Czech Republic.

[1] SCBD/UNEP. 2004. Decisions adopted by the Conference of the Parties to the Convention on Biological Diversity at its seventh meeting. Annex of Report of the Seventh Meeting of the Conference of the Parties to the Convention on Biological Diversity. UNEP/CBD/COP/7/21.
[2] SCBD/UNEP. 2006. Report of the Eighth Meeting of the Parties to the Convention on Biological Diversity. UNEP/CBD/COP/8/31.

Validation of a modified capture-mark-recapture approach to estimate the population size of wild boar (*Sus scrofa*)

C. Thometzek (1), H. Schulz (1), K. Kolodziej (1), C. Ebert (2), U. Hohmann (2), D. Huckschlag (2) & R. Schulz (1)
(1) University of Koblenz-Landau, Institute of Environmental Sciences, Fortstr. 7, 76829 Landau, Germany
(2) Research Institute of Forest Ecology and Forestry, Schlossstr. 16, 67705 Trippstadt, Germany

When absolute estimates of population size are needed in game management, the capture-mark-recapture (CMR) approach is usually used. However, experience has shown high heterogeneity of sex, age class or social status in capture probability of all game species. Therefore, we developed a modified CMR approach for wild boar (*Sus scrofa*) based on individual genotyping ("marking") of scats. The aim of this study was to validate this method in a closed semi-natural gate of 400 ha in the nature park Rhein-Westerwald in Germany. By monitoring of hunting bags and direct counting at 4 feeding sites the population was estimated between 100 and 120 individuals. Scats were sampled ("captured") during 4 days in February 2007 along 6 transects with a total length of 8.8 km. The initial sex determination by a Y-chromosome linked marker was also used as a quality control of the samples. Out of 167 scats collected 103 could be clearly determined showing 65 males and 38 females. For individual identification a set of 6 microsatellite markers was used. All reactions were repeated 3 to 5 times and consensus genotypes were additionally checked by different computer algorithms to minimize genotyping errors due to false alleles or allele dropout. In total, 85 individuals could be identified of which 6 were recorded between 2 and 7 times. But only 4 individuals were "recaptured" on different sampling occasions. Using the model M(h)-Jackknife for closed populations in the CMR-software *MARK* the population size was estimated 201 individuals with a 95 % confidence between 172 and 239 individuals. The study shows, that the modified CMR approach is a useful alternative for absolute population estimates. The accuracy strongly depends on the number of recaptures and accordingly on the sample size.

The 2010 target and beyond – Challenges for conservation biology and policy

6.4. Ecosystem services and resilience as cornerstones for new conservation strategies

Rob Bugter, Josef Settele

Oral presentations

Ecosystem services in Britain's oldest National Park

Aletta Bonn (1), Jon Walker (1), Julia McMorrow (2) & Fred Worrall (3)
(1) Peak District National Park, Moors for the Future Partnership, Fieldhead, Edale, Derbyshire S33 7ZA, UK
(2) University of Manchester, School of Environment and Development, Oxford Road, ManchesterM13 9PL, UK
(3) University of Durham, Dept of Earth Sciences, Science Laboratories, Durham DH1 3LE, UK

Uplands provide a crucial source of ecosystem services, such as water supply, carbon retention, maintenance of biodiversity, provision of recreation, landscape aesthetics and cultural heritage. They are often of exceptional natural beauty, centres of species richness, and historically have been extensively managed due to difficult terrain and thus low productivity. This is reflected in the fact that most upland regions in Britain, as well as globally, receive national and international conservation designations.

The upland landscape of the Peak District National Park, Britain's oldest national park, forms an ideal platform to explore the provision of ecosystem services to people. Surrounded by large conurbations with 16 million people living in 1h drive, the national park is subject to immense environmental and social pressures and delivers vital ecosystem services well beyond its boundaries. This includes provision of 450 million l freshwater water per day to surrounding cities and towns, climate regulation through storage of up to 30-40 Mt carbon and sequestration of up to 26,000 t of carbon per year in peatlands, and recreation opportunities for over 10million leisure visits per year.

Using a GIS based approach we explore the spatial provision of ecosystem services and disservices from the Peak District to surrounding populations. Focussing on carbon sequestration, wildfire regulation and recreation, we discuss supply and demand patterns of these services. Analyses of congruency patterns of ecosystem services and biodiversity and trade-offs between services reveal differences in strength of associations. We discuss how a focus on ecosystem services may support current conservation strategies and/or provide opportunities to alter their direction.

Based on this ongoing case study, we discuss how transdisciplinary approaches for mapping an ecosystem service atlas can provide a process and baseline data for informing decision making in conservation and land management.

Assessment of ecosystems services as a part of water and land management in the Tisza River Basin

Elena Livia Minca, Katalin Petz Rik Leemans, Saskia Werners
Wageningen University and Research Centre, Costerweg 50, Building no. 400, 6701 BH Wageningen, The Netherlands

Providing ecosystem services – the benefits people obtain from ecosystems – is strongly dependent on the capacity of natural processes and ecosystem functioning. The inclusion of ecosystem services in spatial and policy planning is important, since the services are highly influenced by climatic conditions, water management and the institutional context. In Hungary and Romania the required scientific research for the consideration of ecosystem services in spatial planning and in the institutional context is weak. The Tisza River Basin, which is shared by these two countries, is increasingly facing the impacts of floods and droughts. In order to mitigate their effects and to sustain human well-being an integrated approach combining transboundary water and land management and the institutional context is needed. The ecosystem service perspective can provide such an approach.

This symposium aims at discussing the role of ecosystems services and their importance in two cases of the Tisza River Basin by presenting an assessment of ecosystems services in the context of land and water management schemes, policy framework and climate related extremes. The two cases are both pilot areas for new water and land management plans: (1) the Hungarian Bereg Region, where future flood-retention polder plans have been developed under the European Bereg-INTERREG Neighborhood Programme; (2) the Romanian Crişul Negru Basin where the creation of wet areas along the Crişul Negru River has been proposed by the Ministry of Environment. Fourteen ecosystem services are investigated for the following land cover types: arable land, grassland, forest, orchard, wetland, water body and urban environment. The analysis is done for the plot, landscape and watershed spatial scales.

In this symposium a specific framework will be presented focusing on the performance of ecosystem services and the factors that change it. They are: state of ecosystems, weather extremes, recognition, potential, policy measures and water management plans. Firstly, the link between ecosystems services and water and land management will be discussed. Secondly, the expression of ecosystem services in relevant European and national policy acts will be pointed out. The approach follows the similarities and differences between the two countries. Our contribution to the symposium will highlight the importance of ecosystem services and their consideration, both related to the policy context, weather extremes and water management plans in a transboundary context. The discussion will focus on how an integrated ecosystem services assessment can contribute to decision making and planning.

A new paradigm for biodiversity conservation planning

Willemien Geertsema, Koen Kramer, Paul Opdam, Claire Vos
Alterra, Wageningen UR. PO Box 47, 6700 AA Wageningen, The Netherlands

Legally protected nature reserves, managed to prevent and restore unwanted deviations from a conservation goal, are the cornerstones of biodiversity conservation. The goal of conservation is usually expressed in terms of habitat types and target species that are associated with those habitat types[1]. Local changes in abundance of the target species are then perceived as undesirable, triggering management actions on the site. However, climate change is likely to draw apart existing species assemblages as both plant and animal species respond individually to climate change. Thus, habitat type and its predictably associated target species cannot be used anymore as unit of conservation, nor are proper management actions available to restore the situation. Consequently, the conservation paradigm of with static site and species oriented goals and a control management needs revision [2].

Here, we propose a new basis for a conservation paradigm based on concepts of resilienc. We identify three principles as the basis for changes planning practice:

dynamics is an integral aspect of biodiversity planning

resilience and adaptive capacity of ecosystems is determined by functional diversity of species assemblages, and is the best guarantee to prevent extinction of endangered species

the landscape and region are the scales to evaluate nature quality

Based on these three principles, spatial planning conditions can be identified that can be summarised as increasing the connectivity between patches, increasing the interrelation between protected areas and the surrounding landscape, and allowing for more dynamics. Application of these spatial planning principles in biodiversity conservation planning has consequences for the way planning processes are organised. Both the upscaling of the management unit from local to regional scale and the dependence of the quality of natural reserves on the surrounding landscapes requires new co-operations between stakeholders [3].

We argue that application of emerging scientific insight into the inherent dynamics of ecological systems becomes urgent in the light of the predicted implications of climate change and other sources of dynamics caused by economic and political drivers, enforcing societies to profoundly reframe conservation policy and its implementation. We call for a learning process to implement new conservation targets into regional land use planning, based on a broad and profound appreciation of the natural capital provided by ecosystems and their capacity to retain their potential to deliver ecosystem services.

[1] Redford, K. H. *et al.* (2003) Mapping the conservation landscape. Conserv. Biol. 17, 116-131
[2] Pressey, R. L., *et al* (2007). Conservation planning in a changing world. Trends in Ecology and Evolution 22(11): 583-592.
[3] Wallington, T. J. *et al*. (2005). Implications of current ecological thinking for biodiversity conservation: a review of salient issues. Ecol. Soc. 10(1): art 15.

The RUBICODE co-ordination action: introduction and first phase results

Paula A. Harrison (1), Rob Bugter (2), and RUBICODE partners (3)*
(1) Environmental Change Institute, University of Oxford, UK
(2) Alterra Wageningen UR, the Netherlands
(3) See www.rubicode.net
**Contact author: e-mail* rob.bugter@wur.nl

If conservation strategies are really to stop biodiversity loss, there are two obvious requirements to meet: they will have to be adequate and they will have to get implemented. To meet the first requirement, our existing strategies need to be adapted to take the increasingly dynamic character of our present day world and its ecosystems into account. To meet the second requirement, the rather intangible 'threat to biodiversity' needs to be translated into a tangible factor for decision-making. RUBICODE is contributing to meeting the first requirement by taking both natural and anthropogenic (human induced) dynamics into account and to meeting the second requirement by making clear what biodiversity does for us.

Biodiversity provides many services from which humans benefit, such as the provision of food, fiber and fuel, regulation of air and water quality, flood protection, pollination, control of pests, recreation and ecotourism. RUBICODE is developing concepts to define and evaluate those components of biodiversity which provide specific services to society, and is exploring within which limits of dynamics these can be sustainable. The aim is to increase our understanding of the values and limits of biodiversity services and, consequently, of the risks and costs of losing them. This will give decision-makers a more rational base and will improve the understanding of the need to turn protection strategies into adequate conservation policies.

RUBICODE is an EU Coordination Action Project which is reviewing methods for evaluating the sustainability of services in terrestrial and freshwater dynamic ecosystems in relation to socio-economic and environmental drivers of biodiversity change. Frameworks for linking biodiversity traits to service provision and for improving and testing indicators are also being developed and used to explore management strategies and inform priorities for conservation policy. Until now, the project has produced a series of review papers which can be downloaded from http://www.rubicode.net/rubicode/outputs.html on:

- Frameworks and concepts for the quantification of services in dynamic terrestrial and freshwater ecosystems.
- Valuation of ecosystem services.
- Socio-economic and environmental drivers of biodiversity change.
- Indicators and indication approaches for biodiversity and ecosystem services.
- A framework for linking ecosystem service provision to biological traits.
- Habitat management strategies for conservation in dynamic ecosystems.

During the last project phase, RUBICODE will identify gaps in current knowledge and propose a roadmap for future research.

Poster presentations

Mapping providing and benefitting units of ecosystem services

Antonio Castro (1), Javier Cabello (1), Berta Martín (2), Elisa Liras (1), Enrique López (1) & Pedro Aguilera (1)*
(1) University of Almeria, Department of Plant Biology and Ecology, C/ Sacramento s/n, 0412, Spain
(2) Autonomous University of Madrid, Social-Ecological System Laboratory, Department of Ecology, C/ Darwin 2, 28049, Spain

Ecosystem services (ES) constitute a new paradigm to link biodiversity, ecosystem functioning and human well-being. Although its posing allows the incorporation of human dimension in landscape planning, spatially explicit methodologies to assess ecosystem services at local and regional scale are scarce. In this sense, we propose a methodology for the spatial ES assessment through the identification and characterization of landscape units representing service-providing units (SPUs) and potential supporting beneficiaries units (SBUs). The first ones are land units that provide services at the demanded level, and the second ones support a diversity of potential stakeholder`s types, to know the social perception of services. We assumed SPUs are the locations with homogenous ecosystem structure and functioning while the SBUs may be identified as landscape units that covered the spatial range of stakeholders that request ES. To do so, we established three methodological stages; i) hierarchical characterization of land units from the environmental controls and the structure features of ecosystems ii) functional characterization of SPUs by remote sensing derived attributes, and iii) characterization of stakeholders diversity in SBUs through social sampling. Following this approach, we elaborated a land classification map for an area in southeast Iberia, based on the characterization of units at two spatial levels by principal component analysis and clustering techniques. At finer scale (500x500 m cells), the SPUs were identified from land-use and land-cover classes of the territory. At large scale (1x1 km cells), the SBUs were identified from abiotic variables that represent key factors of the landscape structure and finally, the environmental controls of ecosystem functioning. Information from MODIS satellite (NDVI, Normalized Difference Vegetation Index) and derived attributes (NDVI-I and RREL, surrogates of radiation interception and seasonality) were applied for SPUs functional characterization. Finally, we sampled each SBUs by individual surveys to identify the typology of stakeholders. We derived 17 SPUs and 6 SBUs. The functional characterization showed significant differences for average values of NDVI-I and RREL in SPUs, determining differences in the dynamic of ecosystem processes that support the services. Results showed a negative correlation between the values of productivity and seasonality. Thus, high mountains forest had the highest productivity and lowest seasonality while coastland areas shrubland were the least productive and most seasonal SPUs. The SBUs concurred with protected areas boundaries, facilitating their identification and focusing in the role of reserves in the ecosystem services flow. Five types of stakeholders were found: actives tourist, passive tourist, local people with environmental behaviour, local people without environmental behaviour, and workers. In this way, identified SBUs supported a diversity of beneficiaries that will allow the socio-economic and cultural evaluation of ES.

The 2010 target and beyond – Challenges for conservation biology and policy

6.5. Long-Term Ecosystem Research and biodiversity monitoring in Eureope – Towards a new framework for biodiversity and ecosystem research

Thomas Spiegelberger, Kinga Krauze, Rob Jongman, Klaus Henle

Oral presentations

Historical land-use trends and biodiversity change in the Alps

Patrick D. Zimmermann (1), Erich Tasser (1) & Ulrike Tappeiner (1,2)
(1) European Academy of Bolzano, Institute for Alpine Environment; Viale Druso ,39100 Bolzano, Italy
(2) University of Innsbruck, Sternwartestr. 15, 6020 Innsbruck, Austria

Agricultural and industrial revolution induced significant land-use changes all over Europe, bringing along both, abandonment and intensification. In the Alps regionally different developments can be found, depending on the high variety of natural conditions, policy measures and traditional farming systems. According to this, also various patterns in biodiversity change can be expected. In the presented work different historical land-use trends in the Alps are identified and their impact on landscape biodiversity is assessed. Representative Alpine regions were chosen in 8 different agrarian structure regions all over the Alps. By a subdivision into ecoregions also altitudinal aspects were considered. Changes in land-use and habitat type were mapped on the basis of historical maps and airborne images between the 19th century and the year 2000. Collections of phytosociological records from literature provided information on plant biodiversity for each habitat. Considering the spatial and the floristic data, landscape biodiversity was expressed as frequency weighted absolute species richness S_a, area weighted mean species richness S_m and by Rao's quadratic entropy Q as dissimilarity measure. Five land-use trends dominated the agricultural landscapes of the Alps in the past 150 to 200 years: abandonment of grassland, continuous grassland farming, change from mixed agriculture to grassland farming, specialisation on vine and fruit cultivation and continuous mixed agriculture (fig. 1). The highest losses of landscape biodiversity were related to the establishment of vine and fruit farming (up to -61% Q). Moderate abandonment resulted in rising biodiversity (mean: 20% abandoned, +21% Q), whereas strong abandonment (57% abandoned) showed different patterns. In the valleys biodiversity initially increased (+43% Q) but finally decreased again (-11% Q) due to landscape homogenisation. In the subalpine zone the parallel occurrence of different successional stages lead to a continuous increase (+164% Q). Independently from agricultural trends, strong urban-sprawl revealed a high potential to decrease landscape biodiversity (up to -37% Q)

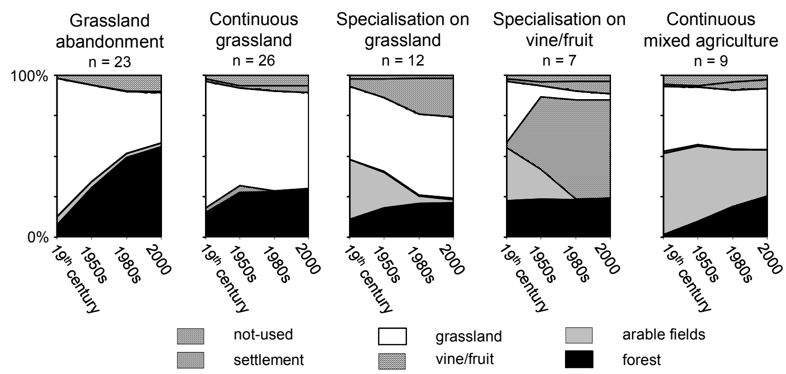

Figure 1: The five main land-use trends in the Alps since the 19th century. n = number of study sites.

The impact of human trampling on the ground vegetation: results from a European transect study

Jutta Stadler (1), Alison Hester (5), Marin Andre (2), Laurent Bergès (3), Andreas Bohner (4), Rob Brooker (5), Bruno De Cinti (6), Thomas Dirnböck (7), Ulf Grandin (8), Mioara Iacob (2), Róbert Kanka (9), Stefan Klotz (1), Jozef Kollár (9), Grégory Loucougary (3), Lars Lundin (8), Giorgio Matteucci (6), Ilona Mészáros (10), Viktor Oláh (10), Elena Preda (2), Bernard Prévosto (3), Juha Pykälä (11), Christian Ripert (3), Wolfgang Schmidt (13), Vojtech Simonovic (9), Michele Taylor (13), Adam Vanbergen (13), Fiorella Villani (6), Theresa Waldmann (13), Markus Bernhardt-Römermann (13); (1) UFZ, Germany; (2) University of Bucharest, Romania; (3) Cemagref, France; (4) Agr. Res. & Educ. Ctr Raumberg-Gumpenstein, Austria; (5) Macaulay Institute, UK; (6) CNR, Italy;(7) UBA, Austria; (8) University Uppsala, Sweden; (9) Slovak Academy of Sciences, Slovakia; (10) Debrecen University, Hungary; (11) Finnish Environm. Inst., Finland,(12) CEH, UK;(13) University Göttingen, Germany

During the last years trampling pressure on natural or semi-natural habitats increased due to recreational use, management, and scientific activities. Trampling damage may lead to changes in plant composition and structure. A controlled trampling experiment was established in forests and grasslands on a pan-European gradient from the boreal zone to the Mediterranean and covering oceanic areas as well as continental parts. This multi-site experiment (carried out within the AlterNet-project on 49 experimental sites) focuses mainly on comparisons of trampling induced vegetation changes concerning the above mentioned gradients. Vegetation surveys and height measurements were applied at several time-steps: Vegetation sampling was done immediately before, 14 days, and one year after trampling. Thus it was possible to analyse changes in vegetation cover and height by calculating relative cover (RC, see formula below, according to [1]) and relative height (RH, calculation according to RC). This aims on the characterisation of reactions of whole communities as well as individual species. For the characterisation of vegetation responses two indices were used: resistance and resilience. Resistance shows the ability of plant communities to withstand trampling and was analysed by calculating RC with initial and vegetation data 14 days after trampling. Resilience shows the ability of plants to recover after trampling damage and was derived by estimating the amount of recovery that occurs one year after trampling.

$$RC = \frac{\text{surviving cover on trampled plots}}{\text{initial cover on trampled plots}} \times cf \times 100$$

with

$$cf = \frac{\text{initial cover on control plots}}{\text{surviving cover on control plots}}$$

First results showed a strong impact on vegetation cover and plant height for intensive trampling treatments irrespective of the estimated community. Less intensive trampling leads to more differentiated pattern when comparing the vegetation types underlying different climatic factors, but principally grasslands react less compared to forests. Further data evaluation will focus on reaction pattern of the investigated communities and species by the use of plant functional traits. By such an approach it may be possible to predict vulnerability of different vegetation types with respect to environmental conditions and community structures.

[1] Cole, D.N. & Bayfield, N.G. (1993) Recreational Trampling of Vegetation - Standard Experimental Procedures. *Biological Conservation* **63**, 209-215.

Vegetation dynamics of springs: acidification, recovery and the response of species and communities

Volker Audorff (1) & Carl Beierkuhnlein (1)
(1) University of Bayreuth, BayCEER, Department of Biogeography; Universitätsstr. 30, 95447 Bayreuth, Germany

As groundwater flow is unidirectional and continual in springs, plants and their diversity in spring habitats is expected to be controlled mainly by hydrochemical conditions. To test which environmental compartments the vegetation of springs is reflecting in fact, we investigated the influence of springwater hydrochemical properties, catchment traits, and spatial configuration on plant species composition of springs in forested catchments.

Many of those, especially on siliceous bedrock, have been strongly influenced by atmospheric depositions, which is reflected by the acidification of ground and surface waters. The temporal dynamics of springwater quality and associated vegetation were investigated by means of repeated measurements in 102 springs from 1989 to 2006.

Vascular plants, mosses and liverworts have been tested in a former project to identify (1) the driving forces of species composition and (2) indicator species, which react sensibly to changes in water chemistry.

In a recent project we repeated the investigation of springwater chemistry and vegetation on different spatial and temporal scales, (3) to test if there is a recovery from acidification (as a consequence of the reduced deposition of acidifying pollutants) and (4) to quantify amplitude and delay of plant species' and community response.

Hydrochemical conditions are found to be more important than physical or spatial factors. Low pH-values accompanied by high concentrations of Al, Cd, Zn and Mn are the main factor that is related to species composition. By means of multivariate ordination techniques *Chrysosplenium oppositifolium* and *Cardamine amara* are identified as indicator species for non-acidic water chemistry, whereas the mosses *Spagnum fallax* and *Polytrichum commune* are found to be dominant under acidic conditions.

Surprisingly, changes in dominance of these selected indicator species can not be directly linked to trends in acidification. While we found a slight trend of recovery from acidification in springwater from 1989 to 2006, the predefined indicator species did not reflect that change. This could be caused by either a delayed reaction due to persistent dominance patterns (inertia) or a longer-integrating reaction, compensating short-term fluctuations in water chemistry. In contrast the response of the whole plant community shows first signs of recovery, which suggests the existence of faster responding species.

Seepage zone vegetation proves to be a good indicator system to characterise groundwater chemistry, which in turn reflects the geochemical and hydrological conditions of forested catchments. Spatial patterns of spring vegetation emerge at various spatial scales and can provide valuable ecological information. Hence we propose to continue this long-term research, .especially because it is to expect that also climate change will affect those habitats, which are originally featured by their relative constancy of hydrophysical and hydrochemical parameters.

What can we learn from long-term research of reservoirs? Cases: land-use changes and effect of climate.

Viera Straškrábová
Biology Centre, Czech Academy of Sciences, Institute of Hydrobiology, Na sádkách 7, České Budějovice, Czech Republic, CZ 37005

Reservoirs (as well as lakes and rivers) integrate changes and processes in their catchments. Drivers and pressures have not only a direct effect on aquatic territory, but also an indirect effect via loading from terrestrial ecosystems in the catchment. The effect of catchment is more pronounced with an increasing flow (flushing rate).

Reservoirs of two different residence times were regularly investigated for more than 30 years and they are one site of the Czech LTER network: Reservoirs in the upper Vltava River watershed. Slapy Reservoir (SL) is the lower part of Vltava River cascade, and it has been regularly investigated in 3 weeks' intervals since 1958. Residence time is 38 days. Long-term data showed a four-fold increase in nitrate concentrations since 1958 up to 1989 [1], reflecting thus fertilizers dosing in catchment [2].

Since 1979, another reservoir – Římov (RI), located on the river Malše (tributary to Vltava), with 100 days'residence time, has been also investigated. In both reservoirs, average seasonal dynamics of chlorophyll for 10 years'periods (1992-2001) were constructed (harmonized per clear water phase), and 3 characteristic points of seasonal cycle were defined [3]: start of spring peak (3rd month), clear water phase (5th month), end of summer peak (10th month) – see Fig. 1. The onset of spring chlorophyll peak (Julian day) was correlated with the preceding winter NAO index = a climate proxy.

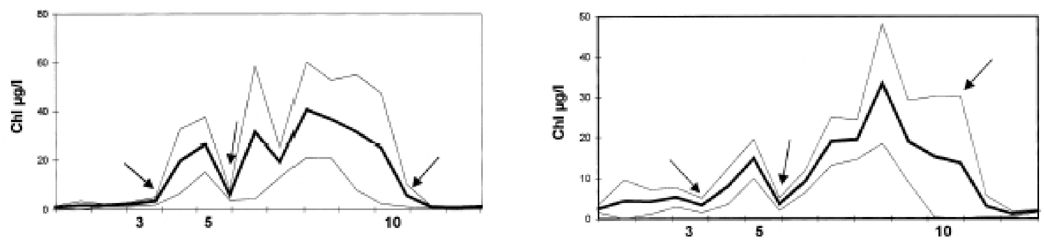

Fig. 1 Average (with +/- average deviation) seasonal changes of chlorophyll in SL (left) and RI (right). Arrows – start of spring peak, clear water phase (end of peak), end of summer peak. X axis – months.

The start of peak was significantly delayed after negative winter NAO in both reservoirs, whereas the duration of the peak was longer after positive winter NAO index in the Římov reservoir only. Correlation with residence time was discussed.

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Range-abundance relationships in Danish Birds, and their implications for biodiversity monitoring

Michael Borregaard & Carsten Rahbek
University of Copenhagen, Center for Macroecology; Universitetsparken 15, DK-2100 Copenhagen, Denmark

Efficient monitoring of species populations is a key element in successful conservation strategies; however, abundance data for threatened species are difficult and costly to acquire. It has been argued that since range and abundance are usually correlated, range size monitoring can be an efficient proxy, and this approach has been implemented in national monitoring programmes, including the Danish Governments nature monitoring programme, NOVANA. The strategy depends on a dynamic relationship between the range size and abundance of a species at different points in time; however, such a relationship is not always found, and both positive, negative and non-significant relationships have been reported in the literature.

In this study, we investigate patterns in the prevalence of dynamic range–abundance relationships of the Danish avifauna, using breeding bird atlases from 1971 to 1974 and from 1993 to 1996. We focus on differences between common and rare species by dividing the assemblage into range-size quartiles. The trend in total population size was determined using an index. Range was determined as grid cell occupancy and standardized to facilitate comparisons between common and rare species. While narrow-ranging species showed strong and consistent range–abundance relationships, the relationships for widespread species were weak and exhibited considerable variation. This may be due to differences in patterns of resource use, since widespread species generally have wider niches, and so may be less affected by resource-based factors linking range and abundance.

Since a tight and dynamic relationship is upheld for rare species, and these are the species that are usually included in monitoring programs, strategies based on range size surveys are supported as a viable proxy for abundance censuses.

An expert system for identifying European Annex 1 habitats in the field.

R.G.H. Bunce
ALTERRA, PO Box 47, 6700 AA Wageningen, The Netherlands. e-mail: Bob.Bunce@wur.nl

The habitats of Annex 1 of the European Union (EU) Habitats Directive have been used to select the Natura 2000 series of sites which form the main legal framework for nature conservation in Europe. However, as has been well documented, these habitats are not defined consistently nor are they in a hierarchical system. They not only include landscape units but also are at different theoretical levels; for example, a single category may comprise only one vegetation association whereas others may be complexes of several classes. Because the habitats have been determined progressively by committees during the expansion of the EU they are not based on scientific principles.

Because of their importance at a European level it would be a major contribution to the development of policies if these habitats could be identified consistently in the field. A further complication is that member states have interpreted the descriptions in the published Manual in different ways.

The first stage in the development of a framework for identifying these habitats consistently has been in the EU Sixth Framework project ECOCHANGE. One part of this project is the development of rules for mapping the Annex 1 habitats using the experience of the PEENHAB study. The rules also needed to be linked to the CORINE land cover map classes. Accordingly, each of the Annex 1 habitats was assigned to a CORINE class, with the addition of information derived from descriptions given in the published Manual, e.g., soil type and Environmental Zone. Where there is sufficient information, predictive maps will be produced of the habitats that are vulnerable to threats such as climate change and abandonment.

This exercise, together with previous work from the Topic Centre in Paris has enabled the development of a hierarchical key using the structure of the General Habitat Categories of the BioHab Fifth Framework project as the first level. Subsequent tiers will be based on deterministic rules, such as the percentage cover of a tree species. The final stage will be developed in consultation with experts with appropriate experience, because judgement will be required from local knowledge. The paper will present examples of the expert system. It is also planned to place the key onto a hand held computer to enable the habitats to be identified in the field. Whilst this system will inevitably involve personal judgement it will be designed to reduce this to a minimum, with the intention of improving the consistency of data on habitats throughout the EU.

Monitoring Landscape Changes in Protected Areas Using Species-Oriented Approaches

Maria Zomeni , Joseph Tzanopoulos , John D Pantis
School of Biology, Department of Ecology, Aristotle University of Thessaloniki, 54124, Greece

Landscapes evolve almost continuously and represent the manifestation of the interlock between natural and anthropogenic processes. This is also the case for Protected Areas (PAs). However, identical landscape changes cannot be evaluated equally in PAs, which have specific conservation utilities, and in unprotected landscapes. Therefore, for monitoring purposes, a species-centred definition of landscapes may need to be adopted, where the different scales at which different species interact with the environment, (i.e. their degree of habitat specialization, their habitat extent and their dispersal capabilities), are taken into consideration. This paper addresses the above issues using a case study approach (Pindos mountain, Greece). The objectives of this paper are: a) to investigate landscape changes within and outside the PAs in order to evaluate the efficacy of the existing protection status, b) to assess the degree of habitat loss and fragmentation inside the PAs through species-oriented approaches and c) to identify management priorities for species and habitat types within the PAs.

Landsat satellite images (of 1985 and 2000) were classified using 'object oriented image analysis and a time series of land-cover maps was established for the entire landscape and for three PAs situated in the study area. For each site the degree of habitat loss and of habitat fragmentation (number and size of remnant patches, habitat connectivity) were assessed using FRAGSTATS. Allometrics were used in order to estimate the dispersal radius and the habitat extent for each of the protected species. Through this approach we were able to transform physical measures of habitat configuration into functional measures that are adapted to each priority species' habitat requirements.

Our study revealed that the entire study area has suffered analogous landscape changes implying that the same anthropogenic processes have occurred within and outside the PAs. Also the 'applied' protection status has proved inefficient in differentiating among the three different systems present in the area (long-term designated, recently designated, non-designated). Despite the recorded habitat loss for forest species, their minimum habitat requirements were still met throughout the PAs. The minimum habitat requirements for shrubland species were also met since these habitats expanded. Species that specialise in grasslands experienced habitat loss and further reduced connectivity. In general, species with large home ranges and high minimum area requirements appear to be threatened of both reduced available habitats and increased habitat patch isolation. We conclude that whilst certain landscape changes may have had a positive impact on the habitat amount or connectivity for some species, still the high isolation among patches of habitats poses a threat for many priority species and future management priorities should focus on measures that improve habitat connectivity. In order to adopt meaningful and effective conservation strategies, monitoring of landscape changes must focus on species-oriented approaches that quantify habitat loss, habitat fragmentation and habitat quality for each species, since different species are expected to perceive the landscape differently.

Automatic acquisition and spatio-temporal monitoring of cultural landscape elements by remote sensing and image analysis

Andreas Voelker
EFTAS Remote Sensing Transfer of Technology GmbH, Oststr. 2-18, 48145 Muenster, Germany, andreas.voelker@eftas.com (Doctoral Student, Institute of Landscape Ecology, University of Muenster)

European landscapes have been formed by people over thousands of years what has lead to poor landscapes with an intensive agricultural utilisation as well as a very heterogeneous cultural landscape, rich of structural elements and a high biodiversity has grown. Because not every intervention into landscape is destructive, over millenniums a complex interplay between anthropogenic and natural influences has been adjusted. So cultural landscapes as a historically grown, culturally affected and still rapidly changing part of the environment constitute a cultural heritage of mankind. The social instruction to secure cultural landscapes in the context of a sustainable development has to be accompanied by interdisciplinary researches, which provide up-to-date methods for acquisition, analysis and assessment of cultural landscapes and their spatio-temporal development. Furthermore landscaping and conservation-monitoring as well as environmental and agricultural administration need suitable tools for everyday use on the current state of scientific knowledge as an initial point for the quantitative and qualitative analysis of cultural and agricultural landscapes

Within a co-operational project of the Institute of Landscape Ecology (ILÖK, University of Muenster) and the company EFTAS Remote Sensing Transfer of Technology GmbH (Muenster) existing models of automatic image analysis are expanded by landscape ecological parameters, which allow a detailed definition of cultural landscape components and their ecological discrimination. Because the acquisition of geodata currently is widely done by manually digitising, the obvious demand on research for supporting large-area monitoring duties is to specify these definitions and models in order to provide them as a knowledge base for the process of automation of cultural and agricultural landscape acquisition.

The specific focal point is put on landscape elements within the scope of agricultural subsidies in connection to Cross Compliance and the Integrated Administration and Control System (IACS) of the European Union. They are extracted with an object-based hierarchical classification and additionally reviewed in a separate image analysis step by evaluating their textural information in order to reduce the manual corrections of the output vector data. The resulting GIS-dataset can be used as an input for the computation of landscape indices in order to evaluate the structural composition of the landscape. For figuring out the temporal characteristics of the landscape structure, several change detection approaches can lead to new insights into the coherence of space and time in landscape genesis.

The automatic acquisition of cultural landscape elements by combining methods of remote sensing and geoinformatics and the usage of a landscape-ecological image analysis model is able to present impartial and standardised methods for the conservation, protection and development of a heavily structured cultural landscape with a high ecological value. The following research aims are the consistent implementation of a large-scale, conferrable (semi-)automatic operationalisation of the spatio-temporal landscape element monitoring.

Species monitoring schemes in Europe: characteristics and potential and benefits for integration of existing schemes

Klaus Henle (1), Pierre-Yves Henry (2), Szabolcs Lengley (3) & Dirk Schmeller (1,4)
(1) UFZ - Helmholtz Center of Environmental Research, Department of Conservation Biology Permoserstr. 15, 04318 Leipzig, Germany
(2) UMR 5173 & UMR 7179, Département Écologie et Gestion de la Biodiversité, Muséum National d'Histoire Naturelle, 55 rue Buffon, 75005 Paris, France
(3) Department of Ecology, University of Debrecen, 4032 Debrecen, Egyetem tér 1, Hungary
(4) Station d'Ecologie Expérimentale du CNRS à Moulis, USR 2936, 09200 Saint Girons, France

In Europe, a large number of biodiversity monitoring activities exist. However, integration of biodiversity information across monitoring schemes is still very poorly developed. The project EuMon "EU-wide monitoring methods and systems of surveillance for species and habitats of Community interest" synthesized information on monitoring schemes for biodiversity in Europe [1]. Currently 446 schemes that monitor species are covered. In our presentation, we first provide a brief overview of characteristics of species monitoring schemes in Europe. We then outline a general framework for combining existing monitoring data with the aim of increasing biological, spatial, or temporal coverage [2]. We present methods to overcome differences in designs among monitoring schemes, such as site selection, post-stratification, and measurement error. We especially emphasize the possible levels of data integration (raw data, parameter estimates, or effect size estimates). We illustrate how the database of the EuMon project could support the integration of biodiversity monitoring along the dimensions discussed. For more information on EuMon or to register your monitoring schemes, see our homepage eumon.ckff.si.

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A statistical framework for combining species atlas data with data on recording effort

Stijn M. Bierman (1), Adam Butler (1), Glenn Marion (1), Ingolf Kühn (2)
(1) Biomathematics & Statistics Scotland, James Clerk Maxwell Building, The King's Building, Edinburgh, EH9 3JZ, United Kingdom
(2) UFZ - Centre for Environmental Research Leipzig-Halle, Department of Community Ecology (BZF), Theodor-Lieser-Str. 4, 06120 Halle, Germany

Species atlases are databases that consist of records of observed presences of species in cells of a rectangular grid that has been superimposed on the landscape. Atlas data are the principal, and for many taxa only, source of data on the spatial distribution of species at large spatial scales, and play a vital role in assessing the impact of environmental change [1]. Atlas data are not collected using standardized survey techniques; they usually consist of the results of both coordinated regional or national surveys and collated historical records, resulting from reported sightings. As a consequence, the detection probabilities will tend to be smaller than one and to vary across both space and time. Inferences from atlas data therefore need to be model-based rather than design-based.

Bayesian Image Restoration (BIR: [2]) provides a general statistical framework to parameterize species distribution models using species atlas data, given scenarios (data collection models) for spatial patterns in mapping intensities. BIR allows for joint estimation of both the distribution of the species and of spatial patterns in detection probabilities. The scenarios can be specified in many ways, for example by relating detection probabilities to some proxy variables that are believed to be correlated with mapping intensities. The resulting 'restored' distribution maps, and the estimated detection probabilities can then be re-assessed by experts for plausibility, and the scenarios rejected or adapted accordingly. We demonstrate the implementation of BIR by fitting species distribution models to maps of recorded presences of plant species of the German atlas of vascular plants (FLORKART), and estimating species- and location-specific detection probabilities consequent on a spatial covariate which experts believe to be related to mapping intensity

We conclude by discussing how monitoring systems can be improved in future, in order to improve the practical utility of species atlas data. In particular, we address the following two issues:

a. how to identify proxy data that can provide good information on the relative detection probabilities associated with different spatial locations;

b. how to design experiments that can be used to estimate absolute detection probabilities for a subset of locations.

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TERENO – A network of terrestrial observatories in Central Germany – Concept for biodiversity research

Steffen Zacharias (1), Mathias Scholz (1) & Mark Frenzel (2)
(1) UFZ Helmholtz Centre for Environmental Research - UFZ, Permoserstr. 15, 04318 Leipzig, Germany
(2) UFZ Helmholtz Centre for Environmental Research – UFZ, Th.-Lieser-Str. 4, 06120 Halle, Germany

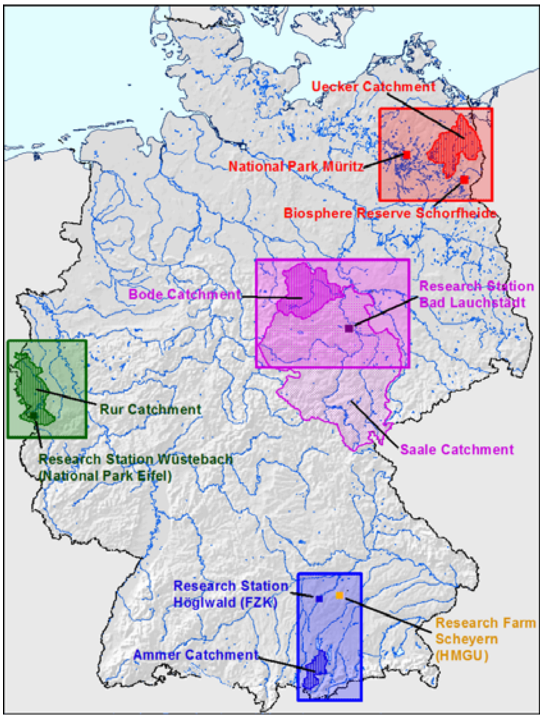

Figure 1: Position and boundaries of the TERENO-observatories

Climate change and land use changes are among most important factors of global environmental change which have to be managed by the society in the next years. Global changes in terrestrial systems take place on different spatial and temporal scales and the resulting challenges for environmental research are immense. Therefore, long-term operated „Global Change Observatories“ for monitoring, analyzing and predicting changing state variables and fluxes within different environmental compartments are of special importance. Starting in 2008 the Helmholtz Association establishes a network of observatories (TERENO – Terrestrial Environmental Observatoria) in different sensitive and representative regions in Germany. The terrestrial system focussed by TERENO consists of the subsurface environment as well as the land surface and includes the biosphere, the lower atmosphere, the hydrosphere and the anthroposphere.

Biodiversity research in TERENO is focusing on the assessment of biodiversity and its function in the regional, landscape and local context along broad environmental gradients as a basis for understanding impacts on and sustainable management of biodiversity under global change. We present an overview about the biodiversity research concept of the TERENO site coordinated by the UFZ. The focus is on semi-natural sites (grasslands, forests) and landscape elements (hedges, field margins) within agricultural landscapes. They are based on a field-site network along gradients used for monitoring and experiments covering different transects which represent gradients in climatic condition and land use. Monitoring covers vascular plants, bees, butterflies and birds and will be tuned with running monitoring programs in the region. Research questions are dealing with land use and climate mediated changes in local adaptation and geneflow (pollen, seeds), pollinator communities, multitrophic indicator systems and ecosystem services like pollination. Another focus is on short- and long-term effects of floodplain restoration on floodplain ecosystem functions and services. An overview of the interdisciplinary study design and first results for biotic (fauna and flora) and abiotic (soil, pollutants, hydrology) factors will be presented.

Towards an integrated European Biodiversity Observation Network

R.H.G. Jongman
Alterra-Wageningen UR, PO Box 47, 6700 AA Wageningen, Rob.jongman@wur.nl

The European Union has 27 members and within these 27 member states many regions with devolved responsibilities. Biodiversity conservation is often a task of regional authorities. The final responsibility for biodiversity conservation is with over 100 regional and national authorities. This means that official monitoring of biodiversity is also with these authorities. Next to these there are hundreds of NGOs monitoring different species groups in a sometimes coordinated, but often non coordinated way. How do we in this huge diversity of data collection system get the overall picture for trends in European biodiversity? This is a key challenge when reporting on reaching the 2010 targets or reporting on the state of the environment in Europe. How can we unify all these data sources in a cost-effective and reliable way? There is a need to develop a system for a coherent system for data collection that can be used for international comparable assessments. The EBONE project aims to do that.

The OECD reports on the economies of countries and international markets as well as on world developments. This can be done because financial and economic approaches and definitions in different parts of the world are comparable. This is not the case for biodiversity. All reporting and all assessments on biodiversity are hampered by the fact that the data used and the way they are collected and analysed is different for all countries and NGOs. Conclusions can therefore not be generalised as is done for other fields such as economics and health. This project initiates common approaches and harmonisation of data from both field observations and earth observations. It will assess the existing approaches on their validity and their applicability starting with Europe, but expanding to other regions of the world. For Europe the FP7-EBONE project is taking up this challenge. Moreover, essential to link the scientific basis of monitoring to a sound organisational framework including both agencies and NGOs to ensures continuity and long term collaboration. The end product should therefore be *„a biodiversity observation network that is spatially and topically prioritized and a structure for an institutional framework allowing European and monitoring and a possible extension world wide including projections on trends based on reliable data and indicators"*

Many projects are on the way within Europe and world wide. The Group on Earth Observations is coordinating efforts to build a Global Earth Observation System of Systems, or GEOSS. GEO was launched in response to calls for action by the 2002 World Summit on Sustainable Development and by the G8 (Group of Eight) leading industrialized countries. These high-level meetings recognized that international collaboration is essential for exploiting the growing potential of Earth observations to support decision making in an increasingly complex and environmentally stressed world. GEO is a voluntary partnership of governments and international organizations. It provides a framework within which these partners can develop new projects and coordinate their strategies and investments. In the GEOSS 10 year implementation plan it is stated that GEOSS "*will unify many of the disparate biodiversity observing systems and create a platform* **abstract absolutely too long/cut**

Poster presentations

Long term dynamics of phytoplankton in shallow lakes from Lower Danube Wetlands Systems (LDRWS)

Mihai Cristian Adamescu, Constantin Cazacu), Angheluta Vadineanu
Department of Systems Ecology and Sustainability, University of Bucharest, Splaiul Independentei 91-95, Bucharest, Romania

Among primary producers the planktonic algae have an important role to play in different water bodies (from deep to shallow lakes and marshes) for exergy accumulation and for shaping the food web structure.

The poster presentation examines the major changes occurred in the composition, structure and functioning (primary production) of phytoplankton, during 1970-2007, from the shallow (2-3.5 m depth) and very shallow lakes (0.5-2 m depth) of the Lower Danube Wetlands System (LDWS), in particular Danube Delta and remnant wetlands of the Inland Danube Delta (IDD).

In that regard a set of appropriate state variables – species and higher taxons composition, biomass and chlorophyll "a" content, nitrogen, phosphorous and carbon contents and, primary production are considered. The variation of the phytoplankton state variables have been checked against recorded values of internal and external driving forces like: pH, nutrient loads and N:P ration, level and frequency of the river pulse, hydrological connectivity, light availability, water temperature, or the presence and development of submerged macrophytes and epiphytes and, primary consumers, extracted from a data base containing more than 40,000 data. The canonical ordination indicates that the variability in the phytoplankton community was accounted by the variation in the magnitude, duration and frequency of the river pulse, nutrient loads and N:P ratio, light availability and water temperature. Prior to 1980 under mesotrophic conditions (N:P>>20; TRP – 20-50 μgl^{-1}), the primary producers from shallow lakes (2-3.5 m depth), have been represented both by the submerged (16 species) macrophytes and epiphytes, with an annual average NPP of 3400 $kcalm^{-2}$ and, the phytoplankton community (>250 species of diatoms, green and blue-green algae) with an annual average NPP of 2300 $kcalm^{-2}$. Between 1980-1984 the shallow lakes experienced a rapid shift towards hypertrophic conditions (DIN – between 1000-1500 $\mu gl^{-1,}$ TRP between 150-250 μgl^{-1}; N:P<10) and the primary producers have been represented alone by the phytoplankton (≤50 species of blue-green algae and diatoms), with an annual average NPP of 10 to 12 thousands of $kcalm^{-2}$. The persistent algal bloom during 1982/1992 was given by blue-green colonial algae, having the ability for atmospheric nitrogen fixation under condition of high level of available phosphorous. In the very shallow lakes (0.5-1.5 m) the planktonic algae contributed with less than 20% to the total annual NPP of 8 to 9 thousands of $kcalm^{-2}$. The rehabilitation of trophic conditions in shallow lakes occurred in earlier 1990^{s} and slowly improved followed by reverse shift in phytoplankton community. The relationships between phytoplankton responses and changes in the structural configuration of LDRWS and nutrient inputs from river catchment are also briefly indicated.

Twelve years of succession on sandy substrates in a post-mining landscape: A Markov Chain Analysis

Annett Baasch (1,2), Sabine Tischew (2) & Helge Bruelheide (1)
(1) Martin Luther University Halle Wittenberg, Institute of Biology /Geobotany and Botanical Garden; Am Kirchtor 1, 06107 Halle, Germany
(2) Anhalt University of Applied Sciences, Dep. Landscape Development, Strenzfelder Alee 28, 06406 Bernburg, Germany

Highly disturbed ecosystems, such as surface-mined land, present great opportunities to explore basic ecosystem processes. Knowledge of the mechanisms, rates and pathways of succession is crucial for understanding the response of the vegetation to disturbance and to design strategies for ecosystem management.

We present Markov chain models of vegetation dynamics based on a long-term study (1995-2007) of a successional dry grassland in a post-mining landscape in East Germany. We analyzed 4 x 2 different Markov models derived from calculated transition probabilities of twelve vegetation types within four time steps and under two contrasting environmental conditions (pH < 4.0, pH > 4.0). The considered vegetation units included pioneer communities with *Corynephorus canescens* and cryptogams, herbal stages (e.g. characterized by *Helichrysum arenarium, Artemisia campestris*, short-lived legumes), stages of competitive grasses (e.g. *Calamagrostis epigejos*) or shrubs and trees.

The successional dynamics were described by the rate of colonization, persistence, replacement and disturbance for the whole system as well as for single vegetation types. Several statistical tests of model assumptions (e.g. stationarity in time and space) and goodness of fit of model predictions were performed.

The probability of bare soil to become colonized remained almost constant over time. However, under more favourable conditions this probability was higher. The probability for a certain vegetation type to become replaced by a different type increased with time. Although the whole system can be considered relatively stable over time, we encountered considerable dynamics between the different vegetation types. We found both progressive and retrogressive trends in vegetation development. Transition probabilities among vegetation types varied in time and space, probably caused by abiotic heterogenity, annual climatic variation and biotic influences.

The entropy as well as the model performance indicated a higher predictability of successional changes at low than at high pH values, suggesting that the assembly rules in harsh environments are stronger than under more favourable conditions.

Trends in long term Ecosystem research and monitoring in Europe

Sabina Raluca Datcu, Constantin Cazacu, Mihai Adamescu, Angheluta Vadineanu
Department of Systems Ecology and Sustainability, University of Bucharest, Splaiul Independentei 91-95, Bucharest, Romania

The poster presentation addresses the first output of the assessment carried out within ALTER-Net project / I3 work package / EU-FP6, aiming: i) identification and selection of existing monitoring and research sites and facilities across Europe which might be used for building an integrated long-term ecosystem and biodiversity research and monitoring infrastructure (LTER); ii) design and develop a structured digital format for collation of information from existing databases of sites and projects; iii) collate most relevant information about a representative pool of sites, established at European scale, where long term monitoring or both monitoring and research activities are carried out; iv) validate the collated information and gather supplementary information in order to ensure that most relevant sources of information has been covered; and v) analyze the collated information along different criteria. For this analysis, a number of 1085 sites from 32 countries belonging to one or more monitoring and research programs and distributed all over Europe, have been assessed. A series of metadata about monitoring and research sites have been collected starting with surface, type of ecosystems, year of establishment, biogeographical region, monitoring and research topics, biodiversity issues addressed, land use, land cover, measured parameters, etc. Analysis of this data revelled that almost 50% (551) of the sites have been established in the late 80^{s} and early 90^{s}, and the data sets are now spanning over 2 to 3 decades. At the same time, there is a limited number of sites with very long data sets about the structure and functioning of different ecosystems types. Almost 80% (860) of the sites have surfaces between 0,1 ha to 10 ha. Only 105 sites extends over 1000 ha up to 100000 ha and are characterised by an increased complexity. The coverage of European heterogenity is uneven, many sites being concentrated on the continental (367 sites) and a few on pannonian (30), Black Sea (1) or stepic (3) biogeographical regions. The analysis also revealed that all sites are designed and equipped to support monitoring activities and only a small number are used for complex research on functioning of different biodiversity components and, that are huge bulks of data and information, mostly generated in the last 3-4 decades. However has been identified a clear trend towards integrating ecosystem and biodiversity structural and functional characteristics in order to allow the assessment of their capacities to provide goods and services. Along this trend the occuring next step is the integration of the existing sites and facilities covering different categories of components of the biophysical structure of the European natural capital with the social and economic diversity within a network of regional socio-ecological systems. That is expected to allow research and monitoring for understanding and assessment the ecosystem and biodiversity dynamics related to social and economic development's drivers and pressures. That, also, is expected to allow the implementation of the DPSIR model and finaly the operationalization of the goals for biodiversity conservation and sustainable development.

Assessment of biodiversity changes in wider countryside: 30 years of grassland changes in Liptov (Slovakia)

Ľuboš Halada (1), Helena Ružičková (2), Stanislav David (1), Andrej Halabuk (1)
(1) Institute of Landscape Ecology SA S, Branch Nitra, Akademicka 2, POB 23B, 949 01 Nitra, Slovakia
(2) Institute of Landscape Ecology SAS, Stefanikova 3, P.O.Box 254, SK-814 99 Bratislava, Slovakia

The monitoring and assessment of long-term trends in biodiversity represents serious challenge for current ecology. There is lack of data allowing assessment of biodiversity changes during last decades, especially in regional context. Precisely located data usually absent or are restricted to few intensively sampled sites (e.g. LTER sites).

Significant transformation of agriculture took place in Central Europe during the second half of the 20th century [1]. This poster reviews the nature of this process and its consequences for structure and biodiversity of fen meadows (*Caricion davallianae, Caricion fuscae*), wet meadows (*Calthion*) and mesophilous grasslands (*Arrhenatherion, Cynosurion*) in the Liptov region (N Slovakia) during the last 30 years. The changes in structure of the rare plant community *Trollio-Cirsietum* (Kühn 1937) Oberd. 1957 were studied in detail. We used the records from 1974-1983 (first period), their location was registered in the map 1:25.000 and from 2002-2003 (the second period), located by the GPS. As the records from the first period were not located precisely in the field, we used method proposed by [2] for testing the importance of time factor for the species composition change.

The increase of registered species number from 92 in first period to 143 in the second studied period represents the most remarkable feature of change. The average species richness increased from 35,64 (30-44) taxa per relevé in the first period to 52,15 (37-63) in the second period what can be assessed as the positive trend. However, the deeper analysis shows that this increase is due by appearance of large group of mesophilous and thermophilous species that did not occur in the community during the first studied period. We recorded also the increase in abundance of characteristic species of seasonally dried meadows of the alliance *Molinion caeruleae*, of mesophilous meadows of the class *Molinio-Arrhenatheretea* as well as of thermophilous grasslands and mesophilous fringes of the class *Festuco-Brometea* and alliances *Bromion erecti* and *Trifolion medii*. In the other hand, we registered the decrease in abundance of species characteristic for permanently wet meadows of the alliance *Calthion*.

This suggests significant changes in the community structure and the loss of typical character of the plant community at least in part of studied sites. A cumulative impact of different factors, especially drainage and intensification of surrounding grasslands as well as abandonment of the community and the global warming can represent reasons responsible for observed changes.

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LTER Europe – developing a new approach to ecosystem research, its communication to stakeholders and implementation

Kinga Krauze (1), Michael Mirtl (2), Mark Frenzel (3)
(1) International Centre for Ecology PAS, Tylna 3, 90-364 Lodz, Poland
(2) Umweltbundesamt GmbH, Federal Environment Agency, Spittelauer Lände 5, 1090 Wien, Austria
(3) Department of Community Ecology, Helmholtz Centre for Environmental Research – UFZ, Theodor-Lieser-Strasse 4, 06120 Halle, Germany

The outcomes of the Millennium Ecosystem Assessment (2004), Global Environmental Outlook (2007) and EEA's "Late lessons from early warnings" report (2001) demonstrated that considering past decisions, having tremendous impact on quality of global environment, the current goal of environmental sciences is to acknowledge and respond to ignorance, uncertainty and risk. That requires adequate, long-term monitoring and research, identification and reduction of knowledge "blind spots", evaluation of alternative options of meeting human and environmental needs, coupling local knowledge with expertise, promotion of interdisciplinarity, and reduction of institutional obstacles to learning and action.

These challenges coincidence with the mission of the International Long-Term Ecological Research network (ILTER), being global network of site-based ecological and socioeconomic research aimed at understanding of global ecological systems and informing solutions to known and unknown environmental problems (ILTER, 2006).

On European scale LTER develops to provide foundation for a new-generation research, which considers the human dimension in a scale- and level-explicit design, and is able to counteract the inefficient fragmentation of the European ecosystem research, including deficiencies in the analysis and synthesis of available information and the communication of results. To facilitate the process, LTER Europe has been structured into the network of sites and platforms for socio-ecological research (LTSER) (Fig.1.). Sites' activities are focused on the dynamics of major aspects of biological and ecological diversity (composition, structure and functioning) under the influence of both natural and human drivers and pressures. LTSER represents entire regions in the sense of cultural, land-use, historical, natural, administrational and economic units and comprise all relevant agents in order to allow for quantitative research in socio-ecological interactions (including ecosystem services). Comprehensiveness of such network opens the door for research efficiently tackling the problems of i) complex socio-ecological mechanisms building up and upon ecological resilience and uncertainty, ii) human perceptions, attitudes and participation related to conservation issues and ecosystem management, iii) development of methods and tools for analysing driver, pressure, state, impact and response interlinkeages, and iv) adaptive management.

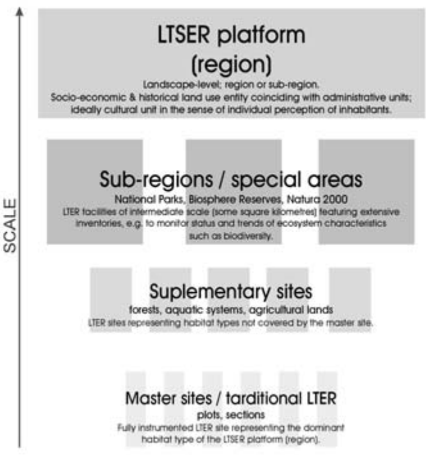

Fig.1. LTER Europe framework for research and action.

Biodiversity - biotope factors relations modeling Carpathian river study case

Letiția Oprean, Angela Curtean-Bănăduc, Ioan Sîrbu &, Doru Bănăduc
"Lucian Blaga" University of Sibiu, Dr. I. Rațiu Str. 5 - 7, 550012, Sibiu, Romania

This study goal is to highlight the importance of the biodiversity quantify for the assessment of the homeostasis degree and of the support capacity of the lotic systems, also it underline the usefulness of the mathematical models which reveal the biodiversity - biotope factors relations, for the prognoses of these systems evolution. The selected study case is the Cibin River, a second order tributary of Danube localized in the middle of Romania. Cibin River has its sources in the glacial lakes of Cindrel Mountains (1920 m altitude), a 82 km length and a 2210 km^2 catchment basin. At least due to the biotope characteristics variation and to a variety of human impact types presence, this river is an interesting one concerning the ecological research. It should to be add the fact that for this river case exist scientific data starting with 1851. This work is based on macroinvertebrates quantitative and qualitative samples, sampled in 1999 - 2005, in 9 sampling stations, also biotope factors (slope, medium watter flow, water phisico-chemical characteristics) were evaluated. Factorial anallysis (correlation and regression anallysis) was used to elaborate the mathematical models which show the benthic macroinvertebrates diversity variation related with the biotope factors variation. The variables were the biotope factors and the benthic macroinvertebrates diversity, expressed trough biodiversity indexes Margalef, Shannon - Wiener and equitability. 107 macroinvertebrates species belonging to 67 genera, 39 families, 16 orders, 10 classes and 6 phylums were identified in Cibin River. The highest macroinvertebrates diversity is in the river mountainous sector, there where the human impact is insignificant. Downstream the diversity is decreasing in parallel with the human impact increasing, reaching a minimum downstream the confluence of the river with the Sibiu locality waste water plant water. Comparing our data with the historical data it has been ascertained the fact that in Cibin River 19 macroinvertebrates species were disappeared and 13 species reduced their distribution along the river. The majority of these stenovalent species has low resistance at the environmental changes induced by the human impact. This dynamic in time point out the river natural habitats degradation, due to the hydrotechnical works presence impact (Gura Râului Dam, river channelization, marshes and floodplain drainage, cut of meanders, river banks reshaping and embanking, tributaries deviations, etc.) and due to the pollution. Achieving the correlation analysis for the considered data set, it was found that significant statistical correlations exist between the benthic macroinvertebrates diversity and the following biotope parameters: slope, dissolved oxygen, organic matter quantities, total hardness, chloride and sulphates quantities, mineralization degree. In the paper were reproduced the regression equations. Conferring values to the independent variables, in the regression equations, the values of the dependent variables can be determined, with a known certain level of error. In this way, possessing a data set which describe the habitat quality, it is possible to estimate the biodiversity like indexes values, like an expression of the analyzed river homeostasis degree. The obtained mathematical models, allow prognosis **abstract too long/ cut**

Investigations of the genetic diversity of *Fraxinus excelsior* L. in the Leipzig Canopy Crane project

Barbara Rudolph (1), Stephanie Bartel (2), Anna Maria Vogt (1) & Pia Parolin (1)
(1) University of Hamburg, Biocenter Klein Flottbek; Ohnhorststr. 184, 22609 Hamburg, Germany
(2) Max-Planck-Institut für Evolutionsbiologie, August-Thienemann-Straße 2, 24306 Plön, Germany

The "Leipzig Floodplain Crane Project" (LAK) is an interdisciplinary project which investigates a temperate floodplain forest for long-term ecological studies. With the help of a crane, set up within the LAK plot, the area can be studied from the soil to the top of the canopy, comprising research of soil attributes, forest structures, species composition – especially in arthropod diversity and distribution within the tree crowns - tree phenology, genetic variability and herbivory. Our part of this project is to investigate the genetic structure and diversity of the common ash tree, *Fraxinus excelsior* L., the main canopy building species in this plot. The aim is to gain insight into regeneration possibilities of the ash tree, possible risks of hybridization events of *F. excelsior* with the neophyte *F. pennsylvanica* and a possible role of somaclonal variation within the trees for their genetic population composition.

On the one hand the species composition of the plot demonstrates that the ash population in this riparian forest has an unusual distribution and regeneration pattern which is most likely the result of different phases of plantings in the 19^{th} century, and damages by roe deer to date [1]. On the other hand the adult individuals and a large number of seedlings and saplings show a high phenotypic variation, especially in floral phenology [2, 3].

For this study, we used AFLP and microsatellite markers to analyse whether phenotypic variation is reflected by a genotypic variation. One main result is that the ash population possesses an astonishingly high level of genetic variation within this population, regarding the putative origin and strong selection of this forest during the last centuries. A comparison of the genetic diversity of this semi-natural ash population with two other ash populations, supposed to be autochtonous – one stand in the north of Germany and one in England – is in progress.

The canopy crane within the LAK gives us the unique opportunity of sampling at any point of the tree crown. Therefore, we chose ten adult trees, exceeding 22 m in height, for the investigation of somatic mutations within ten samples per tree using SSR markers. Interestingly, in eight of ten trees variations of microsatellite loci were identified so far. This opens a new discussion on the use of highly variable molecular markers within populations of long-lived tree species.

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[2] Tal, O. 2007 Comparative flowering ecology of Fraxinus excelsior, Acer platanoides, Acer pseudoplatanus and Tilia cordata in the canopy of Leipzig's floodplain forest Dissertation, University of Leipzig.
[3] Tal, O. & Morawetz, W. 2007: Reproductive biology of the main tree species at the canopy crane investigation site. In: Unterseher et al.: The canopy of a temperate floodplain forest. 2007: 35 – 40

Secondary succession and seed bank formation in overgrazed Pannonian sandy grassland

Péter Török (1,2), Mária Papp (1), Béla Tóthmérész (2) & Gábor Matus (1)
(1) University of Debrecen, Department of Botany, H-4032 Egyetem tér 1., Debrecen, Hungary
(2) University of Debrecen, Department of Ecology, H-4032 Egyetem tér 1., Debrecen, Hungary

Results of a long-term successional study from stands of the lowland sandy pasture, *Cynodonti-Festucetum pseudovinae* Nyírség, East-Hungary, are presented. The studied four stands, two of them in the low and two in the high parts of the dunes, were subject to mass grazing from domestic geese in 1989-90. Vegetation of five 4 m^2 sized permanent plots in each stand was surveyed between 1991 and 2002. Permanent soil seed banks were sampled in spring 2002 then analyzed with seedling emergence method. Unidentified seedlings of monocots were grown till identification.

Initial stages have been characterized by ruderal communities dominated by nitrophilous annual weeds, e.g. *Amaranthus albus*. In 2^{nd}-7^{th} successional years nutrient poor communities of short-lived pioneer herbs *Anthemis ruthenica*, *Erysimum diffusum* and *Trifolium arvense* and of grasses *Apera spica-venti, Bromus tectorum* developed. In the last few years the low stands became dominated by perennial grasses, *Cynodon dactylon*, *Poa angustifolia* and *P. pratensis*. Establishment of wind-dispersed late successional species, *Chondrilla juncea* or *Eryngium campestre*, proved very slow. The influence of initial composition decreased whereas that of altitude increased with time. In high sites species richness and Shannon diversity increased during succession. Most annuals became extinct in low sites but persisted in high ones. Unfortunately the allergenic *Ambrosia artemisiifolia* is among these species. Irrespective of the altitude, the mean species turnover rate decreased during the study.

Almost all herbs and late successional dominant monocots (*Carex stenophylla*, *Cynodon dactylon*, *Poa angustifolia*) possessed detectably dense seed banks. The portion of species with permanent seed banks was as high as 65%. Vegetation of the high stands proved more similar to their seed banks than that of low ones (average Sørensen: high: 0.57-0.59 vs. low: 0.40-0.42; ANOVA, $p<0.05$). Frequent seed bank herbs involved *Arenaria serpyllifolia, Cerastium semidecandrum*, *Conyza canadensis*, *Potentilla argentea*, *Rumex acetosella* and *Trifolium arvense*, no seed banks have however been revealed in *Bromus tectorum*, *Chondrilla juncea* or *Eryngium campestre*. Several hygrophytes (*Carex oederi*, *Juncus* spp., *Typha angustifolia*) have exclusively been detected in the soil and seeds of several pioneers from early years, *Capsella bursa-pastoris* or *Digitaria sanguinalis* persisted. In high stands annual pioneer herbs had more dense seed banks whereas *Cynodon* had more viable seeds in low ones.

Compared to traditionally managed stands, grazed by cattle or sheep, goose grazing resulted in a different altitudinal pattern of vegetation diversity. Low positioned overgrazed stands with extra nutrient input became dominated by a few graminoids and remained rather species-poor. Species of sandy meadows did not establish here and their seeds were also missing from the soil. Spontaneous succession can only lead to a partial regeneration of these grasslands therefore propagule transfer is necessary. A good time for this manipulation is when leaching out of nitrogen from 3rd-5th successional years has happened. In low sites this window closes in the 8-10^{th} year after which the dominance of clonal graminoids will hamper the colonization of target species.

Novel drone-based system for ecosystem monitoring – application, analysis and interpretation

Maik Veste (1) , Ralph Dominik (1), Marin Dimitrov (1) , Anton Fischer (2), Werner Gerwin (1), Wolfgang Schaaf (3)
(1) Research Centre for Landscape Development and Mining Landscapes, Brandenburg University of Technology Cottbus, Germany,
(2) Geobotany, Dept. of Ecology and Ecosystem Management, Munich University of technology Technical University München,
(3) Soil Protection and Recultivation, Brandenburg University of Technology Cottbus, Germany

The complex interactions between structures and processes of an initial ecosystem system development are rarely possible to study under natural environments. Therefore, an artificial water catchment at Welzow South (Lausatia, Germany) was established in 2005 and left to an undirected succession that allows the integrated analysis of all results on a landscape scale. A novel mini-drone system is used for monitoring the vegetation pattern and surface structures. An integrated waypoint-GPS system allows the shooting of exactly repeatable air photos. The drone is equipped with a 10 Mpixel digital camera. Depending from the flight height resolutions of less than 1cm/pixel are possible. Vegetation patterns were analysed with MultiSpec and integrated in the ArcGIS system. Further applications of the mini-drone system for ecosystem monitoring is discussed.

Further informations: http://www.tu-cottbus.de/sfb_trr/

The SFB/TR38 is funded by the Deutsche Forschungsgemeinschaft (DFG)

Figure 1: Application of a micro-drone (left) for montoring of ecosystem structures and vegetation on an artificial watershed Hühnerwasser (Lausatia, Germany).

The impact of human trampling on the ground vegetation of different forest communities

Theresa Waldmann , Wolfgang Schmidt and Markus Bernhardt-Römermann
Georg-August University Göttingen, Faculty of Forest Sciences and Forest Ecology, Department Silviculture and Forest Ecology of the Temperate Zones, Büsgenweg 1, 37077 Göttingen, Germany

During the last years trampling pressure on natural or semi-natural habitats increased because of, e.g., recreational use, management, and scientific activities. Trampling damage may lead to changes in plant composition and structure.

A controlled trampling experiment was established in forests of Central Germany(near Göttingen, Hainich, Solling) to get a closer view on such processes. This study is part of a multi-site experiment (carried out within the AlterNet-project) and focuses mainly on the comparison of reactions between forest ecoysystems with a broad range of site conditions and tree species composition. Vegetation surveys and height measurements were applied at several time-steps: Relevées were made immediately before, 14 days, and one year after trampling. Thus it was possible to analyse changes in vegetation cover and height by calculating relative cover (RC, see formula below, according to [1]) and relative height (RH, calculation according to RC). This aims on the characterisation of the reactions of whole forest communities as well as individual species. Resistance and resilience indices were used to characterise vegetation responses. Resistance shows the ability of plant communities to withstand trampling and was analysed by calculating RC with initial and vegetation data 14 days after trampling. Resilience shows the ability of plants to recover after trampling damage and was derived by estimating the amount of recovery that occurs one year after trampling.

$$RC = \frac{\textit{surviving cover on trampled plots}}{\textit{initial cover on trampled plots}} \; x \; cf \; x \; 100$$

with

$$cf = \frac{\textit{initial cover on control plots}}{\textit{surviving cover on control plots}}$$

First results showed a strong impact on vegetation cover and plant height for intensive trampling treatments irrespective of the forest community. Less intensive trampling leads to more differentiated pattern when comparing the estimated forest types, e.g. coniferous forests react less compared to deciduous.

Further data evaluation will focus on reaction pattern of the investigated forest communities by the use of plant functional traits. By such an approach it may be possible to predict vulnerability of different communities with respect to environmental conditions and community structures.

[1] Cole, D.N. & Bayfield, N.G. (1993) Recreational Trampling of Vegetation - Standard Experimental Procedures. *Biological Conservation* **63**, 209-215.

The 2010 target and beyond – Challenges for conservation biology and policy

6.6. Socio-economic aspects of threats to biodiversity

Joan Martinez-Alier, Joachim Spangenberg, Kaja Peterson

Oral presentations

Agricultural land use and biodiversity changes in EU new member states

Piret Kuldna (1), Kaja Peterson (1), Isabelle Reginster (2) & Nicolas Dendoncker (3)
(1) Stockholm Environment Institute Tallinn Centre, Estonian Institute for Sustainable Development, P.O. Box 160, 10502 Tallinn, Estonia
(2) Department of Geography, University of Louvain, Place Pasteur,3B-1348 Louvain-la-Neuve, Belgium
(3) University of Edinburgh, Centre for the Study of Environmental Change and Sustainability, Drummond Street, Edinburgh, EH8 9XP, UK

Agriculture has been more important sector in terms of agricultural land use, employment and gross value added of agriculture in EU new member states than in old member states. However, the socio-economic and political restructuring during the 1990s have changed land use structure and patterns in new member states significantly. Changes in land use and intensity, in turn, are among the most significant pressures on biodiversity [1]. This study applies the DPSIR (driving forces, pressures, state, impact, responses) methodology and ALARM [2] land use scenarios to analyse the agricultural land use and associated biodiversity changes in 10 EU new member states compared to 15 old member states in the period of 2000 to 2080.

From the three ALARM core scenarios, SEDG – the Sustainable European Development Goal – forecasts the smallest changes in land use compared to the current land use of new member states. The average share of cropland would decrease by around 10% and land for biofuels would increase by 2% up to the year 2080. On the contrary, in GRAS – Growth Applied Strategy – on average, the share of cropland would be 40% smaller and biofuels land approximately 10% bigger than now by 2080. At the expense of reduced cropland, grassland and permanent crop area, in all scenarios surplus land, urban land and forest areas will generally increase. The land use intensity has been especially increasing in new member states compared to 1990s. Increased payments and subsidies to farmers have contributed to higher farm incomes after joining EU, while farm incomes in old member states have increased less at the same time. Demand for using farmland for biofuel production may also be stronger in new member states due to higher availability of agricultural land currently not in use. Legally binding requirements for biodiversity-friendly bioenergy production need to be set at EU CAP level otherwise increased land under monocultures and higher input of chemicals shall contribute to the further loss of biodiversity. In changing agricultural intensity and land use patterns the most threatened are the specialist farmland species [eg birds, butterflies, bumblebees]. At the same time the national Rural Development Programmes 2007-2013 show that budget share of measures aimed at environmental protection and sustainable land management (Axis 2) in new member states are in general smaller than in EU-15 [3]. It is concluded that similar trends in land use are followed in new member states as in old ones but in a shorter period and at a higher speed that may result in biodiversity loss if countermeasures are not taken.

[1] Millennium Ecosystem Assessment (2005). Ecosystems and Human Well-being. Biodiversity Synthesis. World Resources Institute. Washington, D.C.
[2] ALARM – EC 6 Framework Programme project "Assessing large-scale environmental risks for biodiversity with tested methods" (COCE-CT-2003-506675), www.alarmproject.net
[3] European Commission (2007). Rural Development in the European Union. Statistical and Economic Information. Report 2007. Directorate-General for Agriculture and Rural Development.

Land use and bumblebee diversity: comparative study of Kent County (UK) and Tartu County (Estonia)

Meelis Uustal (1), Kaja Peterson (1), Jaan Luig (2), Stuart P. M. Roberts (3), Nicolas Dendoncker (4)
(1) Stockholm Environment Institute Tallinn centre, Box 160, Tallinn 10502
(2) Zoological Museum, Tartu University, Tartu
(3) Agri-Environmental Research Centre, University of Reading, UK
(4) University of Edinburgh, UK

This paper presents an historical analysis (1875-2005) of the relationship of bumblebee diversity, status of vulnerability and the land use. The dynamics of vulnerability of 25 bumblebee species and use of agricultural land was analysed in two pilot areas. One pilot area was Kent County in the UK, representing an old EU member state, where Common Agricultural Policy (CAP) programme has been implemented since its launch in 1981. The other pilot area was Tartu County in Estonia, representing a new EU member state, where CAP measures have been implemented since 2004. Aiming at finding possible dependence of open farmland habitats, such as grassland, and the vulnerability status of bumblebees, historical land use data and bumblebee data in two pilot areas over a period of 130 years was analysed. The results of a comparative analysis of historical land use data in Kent and Tartu show significant fluctuations of grassland and cropland areas. These fluctuations correlated positively with the change in bumblebee diversity and vulnerability status of specialist (e.g. long-tongued) species that depend on certain food plants. Decline of bumblebee diversity and increase of vulnerability follow the declining trend of open habitats, especially of temporary grasslands, such as clover fields, in both pilot areas. In Kent the decline of open habitat bumblebee species (e.g. *Bombus subterraneus, B. distinguendus*) during the 20th century follows the decreasing areas of temporary grasslands and bean fields. By 2005, the "best" status of open habitat bumblebees (5 of 10 species) was the IUCN criterion "Vulnerable" and 3 of 10 species had become extinct (Fig.). Although the status of Kentish bumblebees was already of major concern before 1980, it could still be argued that CAP and associated subsidies escalated the extinction process of open habitat bumblebees during the last 25 years. In Tartu County the decline of open habitat bumblebees dependant on leguminous plants has been less sharp, as a high proportion of temporary grasslands (33% - 37%) during the Soviet period (1950-1990) was still maintained. By the early 21st century the area of temporary grasslands had decreased twofold (ca 17%), and 5 species of 7 open habitat bumblebees have shown increasing trend of vulnerability.

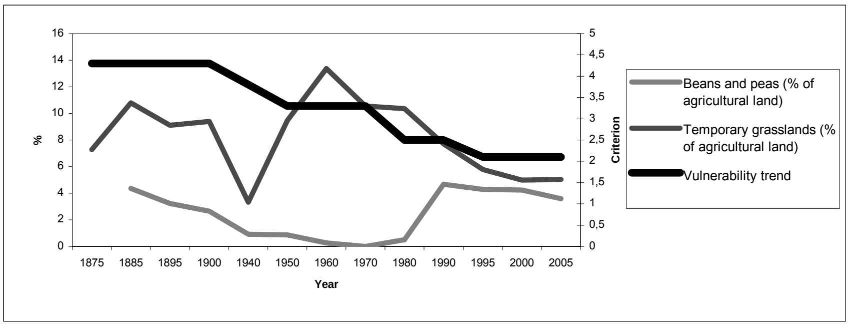

Figure. The dynamics of temporary grasslands and bean fields in Kent and the vulnerability trend of 10 Kentish open habitat bumblebee species. Vulnerability criterion: 5-least concern…0-extinct.

The socio-economics of bioinvasions

Rosa Binimelis (1), Beatriz Rodríguez-Labajos (2), Iliana Monterroso (3), Joan Martínez Alier (1), Mariana Walter (1) &Walter Pengue (4)
(1) Institute of Environmental Science and Technology (ICTA), Autonomous University of Barcelona
(2) Economics and economic history dept., Autonomous University of Barcelona
(3) Latin-American Faculty of Social Sciences (FLACSO), Guatemala
(4) University of Buenos Aires, Argentina

This communication will address different aspects related to the socio-economics bioinvasions through the analysis of a series of case studies.

Dreissena polymorpha and *Silurus glanis* in the Ebro River (ICTA-UAB): Presence of damaging *Dreissena polymorpha* (zebra mussel), detected in the lower Ebro River in 2001, is supposed to be the consequence of an accidental introduction. The same region has been object of deliberate releases of other aquatic invasive fishes as *Silurus glanis* (Wels catfish), enjoying the positive consideration of being used in angling practices. Both kinds of invasions may be interlinked. This case study explores the socio-economic dimension of both cases and compares them in terms of the kind of policy responses in the last years, not only in the Ebro river but also in other watersheds in Catalonia.

Cameraria ohridella in Île de France: The horse chestnut leafminer (*Cameraria ohridella*) was first detected in Europe in 1985 and almost 20 years later, it has spread to most of the continent. Cameraria impacts are mostly aesthetic or cultural while the environmental effects are uncertain and economic ones seem to be low. The paper studies the role of interactions between experts and managers, and workers in gardens, in the conceptualisation of Cameraria and the different perception towards it in the phases of "identification", "impact assessment" and the "selection of alternatives and implementation of responses". The study is based in interviews carried out in Paris in 2007.

Hydrilla verticillat*a* in Guatemala: In 2000 local fishermen reported the presence of an alien species, the macrophyte *Hydrilla verticillata* in Lake Izabal, in North-eastern Guatemala. This is the most important fresh water body connected to the Caribben Sea of 700 km2. Two years later, this alien species established all around the lake shores causing important disfunctions in the ecosystem services, endangering native species and the subsistence of local inhabitants because of impacts on transport, fishing practices and tourism. This case study incorporates stakeholders' views on the invasion process through participatory approaches. Management scenarios are designed using the Social Multi-criteria Evaluation framework employing the NAIADE model. Two evaluations are carried out, technical and social. The social acceptance of different management scenarios, the distribution of costs and benefits, and attribution of responsibility are discussed.

The emergence and spread of a glyphosate-resistant biotype of Johnsongrass in Argentina: Johnsongrass (*Sorghum halepense*) has been introduced in most tropical and sub-tropical regions of the world. Native to the Mediterranean region, it was first introduced as fodder in Argentina at the beginning of the XX century. It is now considered one of the most important agricultural and pasture weeds in this country. Management strategies were based on the use of glyphosate associated with non-tillage practices and the adoption of GM soy. **Abstract absolutely too long/cut**

Bargaining uncertainty: the case study of the insecticide Gaucho®

Laura Maxim (1), Jeroen P. van der Sluijs (2), Jean-Marc Douguet (1)
(1) UMR C3ED n° 063 (IRD-UVSQ), Université de Versailles Saint-Quentin-en-Yvelines, 47 Boulevard Vauban, 78047 Guyancourt cedex, France, tel: +33-1-39 25 50 10, fax: +33-1-39 25 56 88, E-mail: laura.maxim@c3ed.uvsq.fr, jean-marc.douguet@c3ed.uvsq.fr
(2) Copernicus Institute for Sustainable Development and Innovation, Utrecht University, Heidelberglaan 2, 3584 CS Utrecht, The Netherlands, E-mail: J.P.vanderSluijs@uu.nl

In line with the pattern of industrialization of agriculture, systemic insecticides employed in seed-dressing were introduced in the early 1990s. This paper focuses on Gaucho® (active substance: imidacloprid), which is the first from this new generation of pesticides. The risks of Gaucho® for honeybees engendered a strong societal debate in France between 1994 and 2004 and led to the application of the precautionary principle for an environmental issue for the first time in this country. Based on an analysis of this French controversy, this paper explores the relationships between the production and use of scientific knowledge and the socioeconomic stakes present in risk governance.

Imidacloprid is currently under evaluation by the EFSA (European Food Safety Authority) for inclusion on the list of active substances which may be marketed in the European Union. As well, other insecticides from the same family are being considered for use. Based on the experience of Gaucho®, the present paper updates the debate on seed-dressing systemic insecticides, discussing policy alternatives in relationship with the scientific issues involved.

Multi-criteria multi-stakeholder analysis of changes of biodiversity in Ile-de-France region (France)

Laura Maxim, Jean-Marc Douguet
UMR C3ED n° 063 (IRD-UVSQ), Université de Versailles Saint-Quentin-en-Yvelines, 47 Boulevard Vauban, 78047 Guyancourt cedex, France, tel: +33-1-39 25 50 10, fax: +33-1-39 25 56 88, E-mail: laura.maxim@c3ed.uvsq.fr, jean-marc.douguet@c3ed.uvsq.fr

In 2003, the stakeholders in the Ile-de-France region agreed on a Chart meant to structure their willingness to make the Regional Biodiversity known better, preserve and manage it commonly. The Chart does not establish very precise objectives, but only represents an engagement of collaboration and a mean for recognising the existence of a social preoccupation for biodiversity in Ile-de-France.

The objective of the work described in the present paper was to analyse the modalities of implementation of the Chart, using the scientific knowledge available in a multi-criteria multi-stakeholder assessment approach. Beyond the expert assessment, the question of justifications and legitimacy of potential actions is raised by the regional stakeholders. We propose, by using the Deliberation Matrix - a deliberation support tool, to structure this debate on the implementation of the Chart.

Poster presentations

Influence of Informal Institutions at the Village Level on Land Acquisition and Forest Conversion around LLNP in Central Sulawesi (Indonesia)

Sebastian Koch (1,2), Heiko Faust (2), Jan Barkmann (1), Rainer Marggraf (1)
Georg-August-Universität Göttingen, Göttingen, Germany
(1) Department of Agricultural Economics and Rural Development, Platz der Göttinger Sieben 5
(2) Institute of Geography, Human Geography, Goldschmidtstr. 5

Central Sulawesi's Lore Lindu National Park (LLNP) protects core ecosystems of the global Walacea biodiversity 'hotspot'. Progressive forest conversion is widespread, though. We investigated land acquisition and deforestation differences between three contrasting villages based on data from a village census (n=866 households with 1803 agricultural plots in 2004) and qualitative data on informal village institutions (3*10 in-depth interviews in 2007). Village A displays low immigration and a high share of autochthonous residents (88%). Village C is characterised by a high influx of migrants, mostly Buginese (44%) from South Sulawesi. Village B represents an intermediate type (35% migrants). Data on land acquisition show that 29% of all agricultural plots are bought in village A, whereas 55% are inherited, and 6% are cleared from primary forest inside LLNP. In village C, in contrast, 56% are bought, only 18% are inherited and 13% are cleared from forests inside LLNP. In village B, 35% are bought, 41% are inherited and 14% of the plots are cleared from community forest close to but outside LLNP. High levels of forest conversion (villages B, C) are related to the sale of land by locals to Buginese migrants ($p < 0.01$).

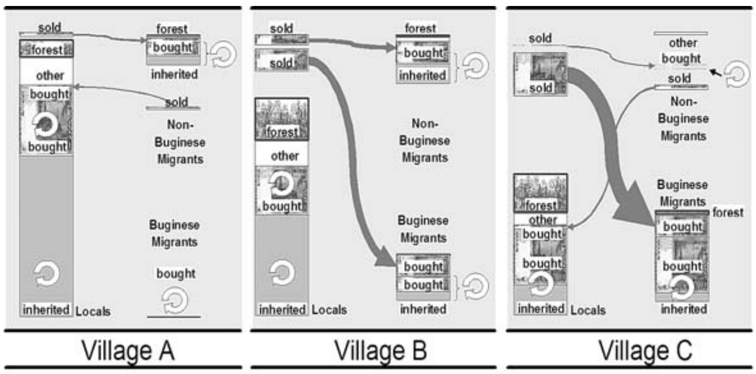

Figure 1: Sources of land owned and land transactions in three socio-demographically contracting villages adjacent to LLNP

Institutional differences investigated via qualitative interviews mediate these patterns of land acquisition and forest conversion. In village A, nearly 'feudal' power relationships are exerted by a group of local "first settler" families that dominates formal village leadership and the influential Counsel of Traditional Leaders (*Lembaga Adat*). This group enforces strict limitations on land sales and on forest conversion. No such institutional restrictions exist in village C. Traditional power relationships are replaced by economic power based on petty capitalist-type production of cacao. While it would be possible for an economically successful migrant to convert land inside hilly LLNP, migrants prefer to purchase better land at the valley bottom for which land titles can be issued. In village B traditional institutions and power structures appear still in place. Because land transfer by locals to economically potent migrants is allowed, however, forest conversion is only little restricted: locals who sold out land to migrants regularly clear new agricultural plots from the community forest just outside LLNP.

Evolution of the agricultural vulnerability of Europe faced to pollinator decline using the ALARM scenarios

Gallai Nicola (1,2), Carré Gabriel (2), Enjolras Geoffroy (1), Reginster Isabelle (3), Salles Jean-Michel (1) & Vaissière Bernard E (2)*
(1) INRA, UMR 406 Abeilles et Environnement INRA-UAPV, site Agroparc, 84914 Avignon cedex 9, France,
(2) LAMETA, UMR INRA-CNRS-Université de Montpellier 1, 2 place Viala, 34060 Montpellier Cedex 1, France
(3) Unité de Géographie, Université Catholique de Louvain, Belgique

Insect pollination is both an ecosystem service and a crop management method which is achieved mainly by bees and affects 80% of the crop species in Europe. Yet there is also evidence of honey bee as well as wild bee decline in Europe and the consequences could be significant in many agricultural areas. To assess these economic consequences, we used a bioeconomic approach, which integrated the production dependence ratio on pollinators, for each of the 89 direct European crops used directly for human food and listed by FAO. We evaluated 1) the 2005 economic value of insect pollination in regards to European agricultural output, and 2) the vulnerability of European agriculture faced to pollinator decline in 2005 and in the future.

Among the 89 crops, 41 are dependent upon or benefit from insect pollination for their production. Pollinators, mainly bees, are essential for four of these crops, great for 12, modest for 13 and little for 12. The 2005 production value for all crops used directly for human food in Europe was €128 billion, while the economic value of insect pollination was €12 billion, or ca. 10% of the production value. This overall figure covers a large range of values among the different crop categories. The most pollinator-dependent crop categories ranked by decreasing economic value of insect pollination were nuts, pulse, fruits and vegetables. The most exposed crop was nuts with a total production value of €348 million. In absolute terms, the most pollinator-sensitive crop category was fruits with more than 20% of their total production value that depended on pollinators. Fruits also represented nearly 63% of the economic value of insect-pollination.

The vulnerability ratio was calculated as the ratio between the economic value of pollination and the 2005 total value for each crop at the European and individual country levels. We found that southern European countries were more vulnerable to pollinator decline than northern ones. We assessed the future trends of European vulnerability using the three main ALARM scenarios: Growth Applied Strategy (GRAS), Business As Might Be Usual (BAMBU) and Sustainable European Development Goal (SEDG). In GRAS and BAMBU scenarios, vulnerability will be increasing in southern countries while decreasing in northern countries, which accentuate the north-south division. In SEDG scenario, the vulnerability decreased all over Europe and as well as the heterogeneity of agriculture vulnerability among countries.

Socio-economic conditions of biodiversity conservation in the Phnom Kulen National Park region, Central Cambodia

Iris Motzke (1) , Erin Guth (2) , Thomas Cherico Wanger (3) & Jan Barkmann (4)
(1) Eberhard Karls Universität Tübingen, Animal Physiological Ecology Department, Germany
(2) Angkor Centre for Conservation of Biodiversity, Cambodia
(3) University of Adelaide, Research Institute for Climate Change and Sustainability, Australia
(4) Georg-August-Universität Göttingen, Department of Agricultural Economics and Rural Development, Germany

Although Cambodia is part of the Indo-Burma Biodiversity 'hotspot', we know very little about its biodiversity, and the socio-economic conditions for biodiversity conservation. For this study, we chose four settlements near and inside Phnom Kulen National Park (PKNP) all located at a single access road from the city of Siem Reap (n = 149 rural households). We address three issues: (i) Land use changes along the town-national park gradient resemble an open access colonisation of a forest frontier; (ii) forest resource utilisation is an important livelihood strategy; (iii) hunting, consumption of wildlife, and its use for traditional medicine plays only a minor role in the live of rural households since wildlife populations are already depleted. We found that land use changes are driven by population growth, regional immigration, and missing land rights. The entire study area is characterised by short-fallow shifting cultivation and low-intensity wet rice production whilst continuous forest cover is restricted to PKNP. Further away from town, land availability and average *chamkar* (shifting cultivation land) size is larger, and the use of forest resources (timber and non-timber forest products) is more dominant. In contrast, wage labour is more important closer to town (Fig. 1). The largely unrestricted colonisation of the forest frontier is in its final stages, and has already reached and trespassed PKNP. We did not find a relationship between the use of non-timber forest products and material well-being. Using high value resources can contribute to a higher wealth status. Timber extraction is quantitatively restricted, however, due to low availability and the illegality of timber extraction. This suggests that most forest resources are used only to sustain or complement income levels; their utilisation is rarely a way out of poverty. Forest resources may also serve as insurance against agricultural crop failures. Only few people hunt wildlife professionally, consume wildlife, or use it for traditional medicine. Availability ratings by local residents indicate a low availability of most populations of larger wild animals. Although the local level of wildlife utilisation is low, remaining hunting pressures may still be too high in face of depleted populations.

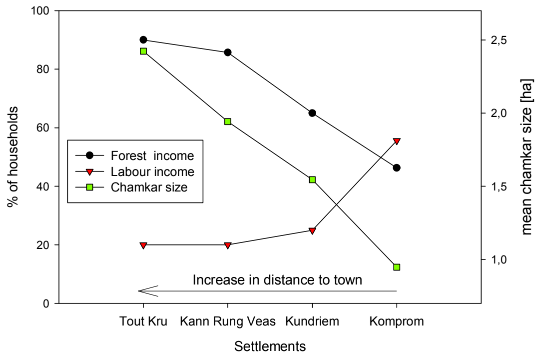

Figure 1: The distribution of the two major income sources "forest" and "labour" and mean chamkar size in the four settlements along the distance gradient.

Because of poverty-driven pressure on forest and forest resources, conservation projects in the project area need to be complemented by developmental projects. In addition, stricter law enforcement for wildlife protection is urgently required to minimize further direct species decline.

Dynamic Modeling, Land Use Change and Local Sustainability

Beatriz Vidal Legaz, Francisco I. Pugnaire de Iraola
Estación Experimental de Zonas Áridas, CSIC; General Segura 1, 04001 Almería, Spain

Turning sustainability into real management processes requires understanding and quantifying links between human and ecological aspects, especially in the Mediterranean Basin where human-environment systems are highly coupled.

Within a multidisciplinary, applied research project, a dynamic model has been developed to help clarify these interactions and to empower local authorities to make sustainable decisions.

Our research focuses on two small, rural villages in Southeast Spain surrounded by forests and areas of outstanding natural value –such as the Sierra Nevada National Park– but also characterised by a depressed and dependent economy.

To acquire data demanded by the model, human and ecological features were characterized, and environ mental and socio-economic diagnosis were drawn, followed by quantification of habitat quality indices and stakeholders participatory workshops.

Variables included into the model are selected by statistical analysis of spatial and non-spatial data, correlation between biophysical variables and land use at different time periods using raster image processing and correlation between socioeconomic indicators.

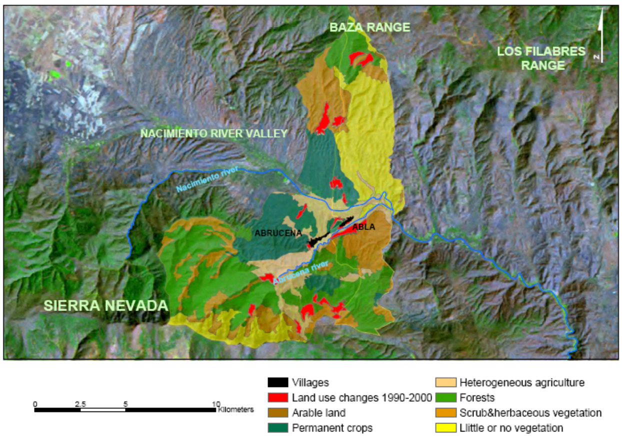

Figure 1: Land use in 2000 year and land use change between 1990 and 2000 (CORINE Land Cover) in the context of a Land Sat image of the research area.

The model includes 5 routines regarding biodiversity, socio-economy, ecological debt and ecosystem services, all of them interlinked through the Land Use Change routine, which connects human driving forces with environmental change leading to understand patterns and processes affecting the local environment.

Land abandonment, growing scattered urban development, low social participation level, increasing demand of water, as well as landscape degradation are the main challenges to the sustainability of this area.

The model will help to draw up sustainability scenarios and to explore their viability.

This approach allows to consider and integrate processes at different spatial and temporal scales and can be used by local decision makers because its friendly user software and outputs.

German session

7.1. Biodiversity and Nature conservation on federal level . Concepts, examples and perspectives

Biodiversität und Naturschutz im bundesweiten Maßstab – Konzepte, Beispiele und Ausblick

Andreas Kruess, Matthias Herbert

Oral presentations

Biodiversitätsindikatoren bilanzieren den Erfolg der nationalen Strategie zur biologischen Vielfalt in Deutschland

Ulrich Sukopp (1) & Werner Ackermann (2)
(1) Bundesamt für Naturschutz; Konstantinstr. 110, D-53179 Bonn
(2) PAN Planungsbüro für angewandten Naturschutz GmbH; Rosenkavalierplatz 10, D-81925 München

Als Vertragsstaat des Übereinkommens über die biologische Vielfalt (Convention on Biological Diversity, CBD) ist Deutschland zur Entwicklung und Umsetzung einer nationalen Biodiversitätsstrategie verpflichtet (Artikel 6 CBD). Im November 2007 hat die Bundesregierung daher eine nationale Strategie zur biologischen Vielfalt verabschiedet [1], welche ein umfangreiches Paket von rund 330 Qualitäts- und Handlungszielen sowie rund 430 Maßnahmen festlegt. In jeder Legislaturperiode wird künftig darüber berichtet, welche Fortschritte bei der Erhaltung der Biodiversität erzielt wurden. Die Bilanzierung und Interpretation von insgesamt 19 Indikatoren bilden die Grundlage dieser Berichte. Zu dem Indikatorenset gehören beispielsweise Indikatoren zur Nachhaltigkeit der Landnutzung, zur Landschaftszerschneidung, Fläche streng geschützter Gebiete, Flächeninanspruchnahme, Gewässergüte oder zum Stickstoffüberschuss in der Landschaft.

Die Biodiversität ist in allen ihren Facetten zu komplex, um mit einem wissenschaftlichen Anspruch vollständig quantifiziert zu werden. Dennoch können wichtige übergreifende Entwicklungen durch exemplarische oder repräsentative Messungen erfasst und mit Hilfe hochgradig aggregierter Indikatoren aufbereitet werden. Solche Indikatoren für die Politikberatung sollen die Auswirkungen menschlichen Handelns auf komplexe Vorgänge in der Natur in zusammenfassender Form abbilden und allgemeinverständliche Aussagen erzeugen. Sie dienen nicht der Erfolgskontrolle einzelner Maßnahmen. Bei der Auswahl und Entwicklung der Indikatoren ergibt sich ein Spannungsfeld zwischen wissenschaftlicher Exaktheit und der Nutzbarkeit der Aussagen für politische Entscheidungsprozesse.

Das Indikatorenset der nationalen Strategie zur biologischen Vielfalt setzt sich zum großen Teil aus bereits bewährten Indikatoren zusammen, die beispielsweise auf europäischer Ebene im SEBI 2010-Prozess (Streamlining European Biodiversity Indicators by 2010) vorgeschlagen wurden oder auf nationaler Ebene im Kernindikatorensystem Umwelt, in der nationalen Nachhaltigkeitsstrategie Deutschlands oder im Rahmen der Länderinitiative Kernindikatoren verwendet werden. Für wichtige Themenfelder werden derzeit folgende fünf Indikatoren im Rahmen eines Forschungs- und Entwicklungsvorhabens des BfN ausgearbeitet: (1) Zersiedelung der Landschaft, (2) Gentechnik in der Landwirtschaft, (3) Erhaltungszustand der FFH-Lebensraumtypen und FFH-Arten, (4) Gefährdete Arten und (5) Bedeutsamkeit umweltpolitischer Ziele und Aufgaben.

[1] Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (BMU) 2007: Nationale Strategie zur biologischen Vielfalt. – BMU, Berlin: 178 S.

Tagfalter-Monitoring DeutschlandErfahrungen aus den ersten drei Jahren

Elisabeth Kühn (1), Reinart Feldmann (2), Alexander Harpke (1), Norbert Hirneisen (3),Martin Musche (1), Patrick Leopold (4) und Josef Settele (1)
(1) Department Biozönoseforschung, Helmholtz-Zentrum für Umweltforschung - UFZ, Theodor-Lieser-Str. 4, 06120 Halle, Germany
(2) Department Umweltbildung und Veranstaltungen, Helmholtz-Zentrum für Umweltforschung - UFZ,, Permoserstr. 15, 04318 Leipzig, Germany
(3) Science & communication, von Müllenark Str. 19, 53179 Bonn, Germany
(4) Pastoratsweg 4, 53343 Wachtberg, Germany

Im Jahr 2005 startete in Deutschland ein bundesweites Monitoring-Programm für Tagfalter (und tagaktive Nachtfalter), das vom Helmholtz-Zentrum für Umweltforschung – UFZ koordiniert wird.

Die Ziele des Tagfalter-Monitoring Deutschland sind (a) der exemplarische Aufbau einer Datenbank zur Erfassung und Analyse der Biodiversität sowie (b) die Untersuchung der Bestandsentwicklung von Schmetterlingen u.a. auch in ihrer Rolle als Indikatoren für den Zustand der Biodiversität. Beide Ziele lassen sich sowohl auf regionalem als auch auf nationalem und internationalem Maßstab verwirklichen. Nachdem das Tagfalter-Monitoring nunmehr seit drei Jahren durchgeführt wird (2005-2007), präsentieren wir erste Ergebnisse und Erfahrungen. Wir zeigen, dass die Einbeziehung verschiedener Medien (Fernsehen, Internet, diverse Foren etc.) zu einem hohen Bekanntheitsgrad in der Öffentlichkeit geführt hat und eine große Zahl an ehrenamtlichen Transektzählern geworben werden konnte. Des Weiteren zeigen wir, dass die Qualität der Daten geeignet ist, um wissenschaftliche Analysen zur Abundanz sowie zur Flugzeit der Arten durchzuführen. Zukünftig sollten die im Rahmen des Tagfalter-Monitoring erfassten Daten auch zur Erfassung von Langzeittrends herangezogen werden können.

Die wichtigsten Erfahrungen, die wir bei der Etablierung dieses Monitoring-Projektes machen konnten (welches v.a. von ehrenamtlich tätigen Zählern durchgeführt wird) sind die folgenden:

1. Eine Institution, die solch ein Projekt koordiniert, sollte in der Lage sein, eine langfristige Finanzierung und personelle Ausstattung zu sichern.
2. Die Einbeziehung der Medien spielt eine wichtige Rolle, um ein solches Projekt erfolgreich starten zu können. Durch Berichte in Fernsehen und Zeitungen konnte rasch eine ausreichende Anzahl an Zählern geworben werden, um vom ersten Jahr an mit einer wissenschaftlich auswertbaren Datenbasis arbeiten zu können.
3. Die Motivation der Zähler ist letztendlich der Schlüssel zum Erfolg. Hierzu ist es wichtig, dass eine Koordinationsstelle ständig erreichbar ist und Fragen möglichst kurzfristig beantwortet werden. Verschiedene Aktivitäten (regionale Treffen, Exkursionen, bundesweite Tagungen), regelmäßige Information der Transektzähler sowie Neuwerbung von Zählern tragen dazu bei, dass regelmäßig Schmetterlingsdaten erhoben werden und das Projekt langfristig erfolgreich sein kann.

Representativeness of endangered species in the European Natura2000 network

Bernd Gruber (1), Bianca Bauch (2), Klaus Henle (2), Ralf Seppelt (1) & Carsten F. Dormann (1)
(1) Helmholtz Centre for Environmental Research,Department of Computational Landscape Ecology; Permoserstr. 15, 04318 Leipzig, Germany
(2) Helmholtz Centre for Environmental Research,Department of Nature Conservation; Permoserstr. 15, 04318 Leipzig, Germany

Designating protected areas is widely recognized as the most effective measurement to prevent species from extinction. Accordingly, there has been a tremendous effort by governments worldwide in the creation of over 100,000 sites to achieve the 10% target proposed at the Fourth World Park Congress in 1992 in Caracas. The main European effort to achieve this target is the so called “Natura2000” network of protected areas, comprising presently 12.8 % of the area of the 27 member states of the European Union in over 20000 sites. Designation of Natura2000 sites was based mainly on species listed in the Annexes of the Habitats Directive. The effectiveness of the selection process and the existing Natura2000 network has often been questioned – but not yet analysed – as each state made its designations largely independently, in most cases without references to theory of optimal reserve site selection. Our analysis shows that the Natura2000 network is effective in avoiding gap species (only 15 out of 905 species), but the representativeness of Annex species is very skewed (Figure 1). Representations vary considerable between species groups with mammals, amphibians, reptiles and fishes being well covered, but plants and invertebrates still insufficiently protected. The long-term survival of a species protected in a country profits from Natura2000 sites designated in other countries. This benefit was low for countries located at the geographic margins of Europe, due to their higher proportion of endemic species, which by definition, cannot be protected in other countries. We argue that representativeness can be used to determine gaps in the network of protected sites, and therefore as a rapid assessment tool guiding the efficient allocation of future conservation efforts.

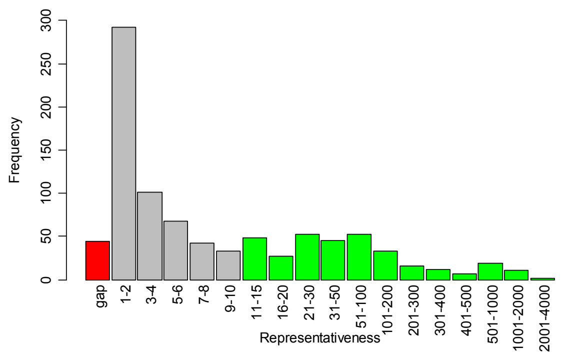

Figure 1: EU-wide representativeness of the 905 Annex species in the Natura2000 network of the 27 countries of the European Union in 2007. Species with no representation (gap species: 44 / 905) are indicated by a red bar and

Erfolgskontrolle von Hartholz-Auenwaldaufforstungen am Beispiel der Mittleren Elbe

Kreibich, M; Glaeser, J.
Author informations missing

Hartholz-Auenwälder (*Querco-Ulmetum minoris*) zählen zu den artenreichsten Ökosystemen Europas. In den letzten Jahrhunderten ist jedoch der Anteil der Auenwälder durch die Eingriffe des Menschen drastisch zurückgegangen. Dadurch gehören Auenwälder heute zu den gefährdeten Lebensräumen Mitteleuropas, die vielerorts als FFH-Gebiete ausgewiesen sind. Angesichts dieser hohen naturschutzfachlichen Bedeutung ist die Neuanlage von Auenwäldern ein wesentlicher Bestandteil in aktuellen und geplanten Rückdeichungsprojekten. Die Pflanzung von Auenwaldbäumen ist oftmals mit großen Schwierigkeiten verbunden, da die Gehölzarten nicht nur dem Einfluss von Überflutung und Eisgang unterliegen, sondern durch Wildverbiss stark geschädigt werden können sowie zusätzlich mit einer kräftigen Krautschicht um Licht konkurrieren.

Im Rahmen des EU-LIFE Projektes „Renaturierung von Fluss, Altwasser und Auenwald an der Mittleren Elbe“ fand in der Kliekener Aue (Sachsen-Anhalt) bereits im Jahr 2000/01 die Neuanlage von Hartholz-Auenwäldern statt. Auf ehemaligem Acker-, Grün- und Weideland erfolgte dabei unter Verwendung verschiedener Pflanzkonzepte die Entwicklung von 60 ha Hartholz-Auenwald. Ziel der im Jahr 2007 durchgeführten Erfolgskontrolle war die Ermittlung des Etablierungserfolges der Hauptbaumarten *Fraxinus excelsior*, *Quercus robur* und *Ulmus* spec. unter verschiedenen hydrologischen Bedingungen, woraus Schlussfolgerungen für zukünftige Aufforstungen abgeleitet werden können.

Pro Aufforstungsfläche wurden für jede Baumart folgende Parameter erfasst: Vitalität, Höhe, Brusthöhendurchmesser und Ausfall in Klassen. Zusätzlich fand die Erfassung der Sukzession statt. Neben der Berechnung der Überflutungsdauer erfolgte auf ausgewählten Standorten die Bodenansprache mittels Bohrstock bis zu einer Tiefe von 2 m.

Die Ergebnisse der Erfolgskontrolle zeigen, dass die Standorteigenschaften (Boden, Hydrologie) einen bedeutenden Einfluss auf den Anwuchserfolg von *Fraxinus excelsior*, *Quercus robur* und *Ulmus* spec. haben. In der Altaue konnte sich der Hartholz-Auenwald sehr schlecht etablieren, was wesentlich auf den hohen Grundwasserstand zurückzuführen ist. Auf diesen Nass-Gley-Standorten war eine starke Sukzession von *Alnus glutinosa* zu beobachten, die längerfristig die Etablierung der Hauptbaumarten des Hartholz-Auenwaldes einschränkt. Weiterhin konnte trotz der hohen Überflutungstoleranz von *Quercus robur* in den Rinnen eine höhere Ausfallrate der Stiel-Eiche nachgewiesen werden als auf den wenige Dezimeter höher gelegenen Auenbereichen. Neben den Standorteigenschaften wirkte sich die Umzäunung der Aufforstungsflächen entscheidend auf den Anwuchserfolg aus. Sowohl *Fraxinus excelsior* als auch *Quercus robur* und *Ulmus* spec. weisen auf den gezäunten Flächen eine deutlich bessere Entwicklung auf als im ungezäunten Bereich.

Klimawandel und Naturschutz- Wie gefährdet sind Seen in Deutschland?

Olivia Roithmeier,, Katrin Vohland
Potsdam-Institut für Klimafolgenforschung, Abt. Klimawirkung und Vulnerabilität, Telegraphenberg A62, 14473 Potsdam, Germany

Der Einfluss des Klimawandels auf die Biodiversität und Lebensräume wird am Potsdam-Institut für Klimafolgenforschung in unterschiedlichen Zusammenhängen erforscht, u.a. in dem EU-Projekt ALARM (Assessing LArge scale Risks for biodiversity tested with Methods) sowie dem Projekt „Schutzgebiete Deutschlands im Klimawandel - Risiken und Handlungsoptionen“, finanziert vom Bundesamt für Naturschutz (BfN). Im Rahmen dieser Projekte wird untersucht, wie der Klimawandel Seen in Deutschland beeinflusst. Hierfür wird für eine Vielzahl von Seen eine Vulnerabilitätsanalyse durchgeführt. Dabei werden unterschiedliche Seenparameter, wie z.B. Morphologie und Durchfluss, hinsichtlich ihrer Bedeutung für klimainduzierte Veränderungen analysiert. Anwendung findet die Methodik der Bayesischen Netzwerke, die zunehmend auch in der Umwelt-Risikoanalyse eingesetzt wird. Abschließend wird anhand einer Vulnerabilitätskarte diskutiert, welche Seen in Deutschland wie stark gefährdet sind, was sie vulnerabel macht und an welcher Stelle Managementoptionen im Rahmen des Verschlechterungsverbotes der FFH-RL greifen, wenn es z.B. um die Gefahr der Austrocknung von Seen oder Veränderungen im Mixisregime von Seen geht.

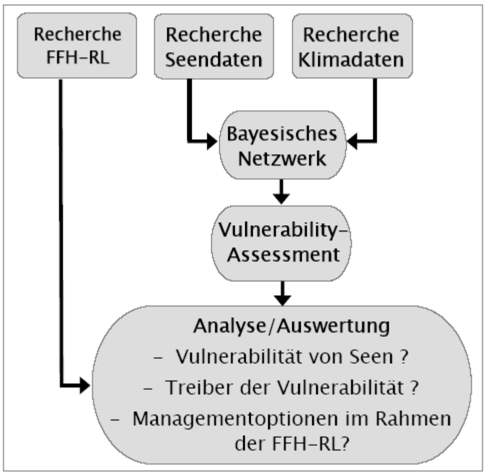

Abbildung 1: Konzeptdiagramm des Projektes

Internet-Links
EU-Projekt ALARM- Assessing LArge scale Risks for biodiversity tested with Methods
http://www.alarmproject.net/alarm/

Schutzgebiete Deutschlands im Klimawandel - Risiken und Handlungsoptionen
F & E Projekt des Bundesamtes für Naturschutz (FKZ 806 82 270 - K1)
http://www.bfn.de/0316_klima.html

Schutzgebiete Deutschlands im Klimawandel - Risiken und Handlungsoptionen
http://www.pik-potsdam.de/ vme/schutzgebiete

Protected areas in Germany – risks and management options
http://www.pik-potsdam.de/ vme/schutzgebiete

Modellierung der Auswirkungen des Klimawandels auf die Flora in Deutschland

Ingolf Kühn (1), Sven Pompe (1), Jan Hanspach (1), Franz-W. Badeck (2) & Stefan Klotz (1)
(1) Helmholtz-Zentrum für Umweltforschung – UFZ, Dept. Biozönoseforschung, Theodor-Lieser Str. 4, 06120 Halle, Germany
(2) Potsdam-Institut für Klimafolgenforschung (PIK), Telegraphenberg A 31, 14473 Potsdam, Germany

Das Klima spielt eine wichtige Rolle bei der Ausbildung von Pflanzenarealen. So werden Pflanzen u. a. durch Frost; Trockenheit oder eine zu kurze günstige Wachstumsphase begrenzt. Da Pflanzen noch andere Ansprüche an sie begrenzende Umweltfaktoren, wie Boden oder Landnutzung besitzen, kommen sie nur unter bestimmten Kombinationen in einem Gebiet vor; diese Kombinationen tragen somit zur Differenzierung von Pflanzenarealen bei. Umweltfaktoren ergeben damit einen charakteristischen bioklimatischen Fingerabdruck für jede Art. Eine Temperaturerhöhung und die Änderung der Niederschlagsmuster, wie sie Klimaszenarien simulieren, könnten bisherige Verbreitungsgebiete maßgeblich beeinflussen.

Mögliche Risiken durch Klimawandel sind für die Flora Deutschlands nicht unwahrscheinlich. Bisherige Untersuchungen über mögliche Arealveränderungen liefern noch keine geeignete Gefährdungseinschätzung für die in Deutschland vorkommenden Pflanzenarten. Das Forschungsprojekt „Modellierung der Auswirkungen des Klimawandels auf die Flora" des Bundesamt für Naturschutz, der Leibniz- Universität Hannover, dem Potsdam-Institut für Klimafolgenforschung (PIK) und dem Helmholtz-Zentrum für Umweltforschung - UFZ (Koordination), untersucht die Klimasensitivität von Gefäßpflanzenarten auf der Basis von modellierten und bereits beobachteten Arealverschiebungen. Damit sollen unter anderem erste Grundlagen für eine naturschutzfachliche Bewertung klimainduzierter Veränderungen in Deutschland erarbeitet werden.

Angesichts des prognostizierten Klimawandels sind Auswirkungen auf die Pflanzenwelt zu erwarten. Die Verbreitungsgebiete von Pflanzen könnten dabei durch sich ändernde Umweltbedingungen und Landnutzungswandel klimainduziert maßgeblich beeinflusst sein. Modellrechnungen ergaben, dass sich in Abhängigkeit von moderater (ca. +2°C, mittlerer (ca. +3°C), oder starker (ca. +4°C) Klimawandel-Prognose Areale verschieben oder Areale von besonders klimasensiblen Arten in Deutschland bis zum Ende des Jahrhunderts verloren gehen.

In den Szenarien variieren lokale Verlustraten von 15 % to 35 % Arten. Spezies der Roten Liste könnten durch Klimawandel weitergehend gefährdet sein. Mehr als die Hälfte der getesteten Arten mit Gefährdungsstatus können bei starkem Klimawandel durch Arealverlust bedroht sein.

Nationalpark Wattenmeer als Chance für Wiesenpieper und Rotschenkel? Auswirkungen von Nutzungsänderungen in Salzwiesen auf Wiesenbrüter

Martin Maier (1), Klaus-Michael Exo (2) & Julia Stah1 (1)
(1) Universität Oldenburg, AG Landschaftsökologie, Postfach 2503, 26111 Oldenburg, Germany
(2) Institut für Vogelforschung „Vogelwarte Helgoland", An der Vogelwarte 21, 26386 Wilhelmshaven, Germany

Die Bestände zahlreicher Wiesenvogelarten weisen im Binnenland in den letzten Jahrzehnten drastische Bestandsrückgänge auf. Vergleichbare Entwicklungen sind im Bereich der Vorlandflächen an Nord- und Ostsee nicht zu erkennen. Auf den Vorlandflächen fand keine mit Grünland vergleichbare Intensivierung der Flächennutzungen statt, sondern es kam zu großflächigen Extensivierungen und Nutzungsaufgaben im Zuge der Einrichtung der Wattenmeer Nationalparke. Diese Nutzungsänderungen wirken sich mit zeitlicher Verzögerung auf die Struktur sowie die Zonierung der Vegetation aus. Wie stark sich diese Veränderungen auf Brutvögel der Salzwiesen auswirken, wird für die Festlandssalzwiesen des Nationalparks Niedersächsisches Wattenmeer exemplarisch anhand von zwei typischen Brutvogelarten (Wiesenpieper *Anthus pratensis* und Rotschenkel *Tringa totanus*) untersucht.

In vier Untersuchungsgebieten entlang der niedersächsischen Festlandsküste wurden die Neststandorte beider Arten, die Vegetationsstruktur im Bereich der Nester sowie an Zufallspunkten erfasst. Zudem wurden der Abstand zu offenen Wasserflächen und die Höhe über MTHW ermittelt. Barberfallen und Kescherfänge gaben Auskunft über das Arthropoden-Nahrungsangebot auf verschieden genutzten Salzwiesen. Der Einfluss der unterschiedlichen Landnutzungsformen (Brache, Mahd, Beweidung) auf die Brutplatzwahl von Rotschenkeln und Wiesenpiepern wurde mit Hilfe logistischer Regression modelliert und für beide Arten wurden Habitatmodelle erstellt.

Mit einer Kombination aus vertikaler und horizontaler Vegetationsdichte lässt sich die Neststandortwahl beider Arten gut erklären. Das Nahrungsangebot in der Phase der Jungenaufzucht unterschied sich deutlich zwischen beweideten Salzwiesen und anderen Nutzungsformen. Auf beweideten Flächen wurden signifikant geringere Anzahlen an Arthropoden festgestellt als auf gemähten oder ungenutzten Flächen.

Durch die Habitatmodellierung ist es möglich sich dem komplexen Wirkgefüge brütender Wiesenvögel anzunähern um herauszufinden, welches letztlich die relevanten Habitatparameter für eine erfolgreiche Brut sind. Diese Informationen sind insbesondere für Managementplanungen und zur Prognose von Auswirkungen bei Nutzungsänderungen von hoher Relevanz.

Eingriffsfolgenbewältigung und Artenschutz - Naturschutzfachlich-planerische Anforderungen unter Berücksichtigung von CEF-Maßnahmen

Matthias Herbert (1) & Holger Runge (2)
(1) Federal Agency for Nature Conservation, Department Landscape Planning and Design, Karl-Liebknecht-Str. 143, 04277 Leipzig, Germany
(2) Planungsgruppe Umwelt GbR, Stiftstr. 12, 30161 Hannover, Germany.

Ausgehend von gemeinschaftlichem und nationalem Recht ist es verboten, wild lebende Tiere der streng geschützten Arten und der europäischen Vogelarten während der Fortpflanzungs-, Aufzucht-, Mauser-, Überwinterungs- und Wanderungszeiten erheblich zu stören. Für Eingriffe im Sinne des Bundesnaturschutzgesetztes ist nach § 42 Abs. 5 BNatSchG eine Störung für Arten nach Anhang IV FFH-RL sowie für die europäischen Vogelarten dann nicht gegeben, wenn die ökologische Funktion der vom Eingriff oder Vorhaben betroffenen Fortpflanzungs- oder Ruhestätten im räumlichen Zusammenhang weiterhin erfüllt werden. Hierzu können auch vorgezogene Ausgleichsmaßnahmen festgesetzt werden.

Der Bundesgesetzgeber ist hier dem Vorschlag der Europäischen Kommission gefolgt, die ihrem Leitfaden zum Artenschutz Maßnahmen zur Vermeidung des Verbotseintritts im Sinne v. Art. 12 FFH-RL oder Art. 5 V-RL entwickelt hat (CEF-Maßnahmen: measures to ensure the continued ecological functionality of breeding sites and resting places = Maßnahmen zur Sicherstellung der kontinuierlichen ökologischen Funktionalität von Fortpflanzungs- und Ruhestätten).

Im Vortrag soll auf die naturschutzfachlichen Anforderungen an den besonderen und strengen Artenschutz im Rahmen der Eingriffsfolgenbewältigung zu Fachplanungsverfahren eingegangen werden. Dabei wird das spezifische Aufgabenprofil der einzelnen Planungsebenen und Prüfinstrumente herausgearbeitet.

Im Vortrag sollen u.a. folgende Aspekte thematisiert werden:

a) Naturschutzfachliche Anforderungen an die Eingriffsfolgenbewältigung im Hinblick auf den Artenschutz unter besonderer Berücksichtigung der spezifischen Potenziale einzelner Planungsebenen

b) Naturschutzfachliche / ökologische Anforderungen an vorgezogene Ausgleichsmaßnahmen bei Verkehrsinfrastrukturmaßnahmen (CEF-Maßnahmen)

c) Anwendungsbereich vorgezogener habitat- und populationsstützender Maßnahmen

d) Anforderungen an die Prognosesicherheit der zu ergreifenden Maßnahmen / Umgang mit verbleibenen Risiken

e) Verhältnis zu anderen rechtlichen Regelungen (Eingriffsregelung, FFH-RL, UVP-RL, Umwelthaftungs-RL)

Biodiversität im Siedlungsraum

Torsten Wilke, Alice Kube
BfN,FG II 3.1,Karl-Liebknecht-Str. 143,04277 Leipzig

Der Beitrag soll den aktuellen Wissenstand aus Forschung und Praxis im Themenfeld „Biodiversität im Siedlungsbereich“ aus Sicht des Bundes darstellen. Das BfN hat in den letzten Monaten zahlreiche Projekte initiiert, um den Wissenstand in der Forschung sowie Ansätze aus der Praxis zur Erhaltung der Biodiversität im Siedlungsbereich zu eruieren, Wissensdefizite, Forschungs- und Handlungsbedarf zu identifizieren und erste Handlungsansätze auf der Umsetzungsebene zu entwickeln. Der Beitrag wird die (Zwischen-)Ergebnisse dieser Projekte darstellen und in Beziehung setzen zu den nationalen Zielsetzungen aus Biodiversitätsstrategie, Nachhaltigkeitsstrategie und Klimaanspassungsstrategie. Dabei steht nicht nur die Artenvielfalt des Siedlungsraumes im engeren Sinne im Fokus, sondern vor allem auch die ecosystem services im unmittelbaren Wohnumfeld des Menschen.

Energetische Biomassenutzung: Landnutzungssysteme naturverträglich gestalten Strategien und Beispiele aus Deutschland

Dr. Wolfgang Peters (1) & Christian Schultze (2)
(1) Peters Umweltplanung, Streitstr. 11-14, 13587 Berlin, Germany.
(2) Federal Agency for Nature Conservation, Department Renewable Energies, Karl-Liebknecht-Str. 143, 04277 Leipzig, Germany

Die Land(wirt)schaft ist im Wandel: Gestiegene Nachfrage nach agrarischen und forstlichen Rohstoffen, neue Kulturen, veränderte Produktionsweisen haben Auswirkungen auf Natur und Landschaft. Die Politik der ländlichen Entwicklung und der Naturschutz stehen vor der Herausforderung diesen Wandel konstruktiv zu begleiten und zu steuern. Besonders deutlich wird die Umstrukturierung der Landschaft durch die Etablierung von neuen Landnutzungssystemen, allen voran der verstärkte Anbau von Energiepflanzen. Die nachwachsenden Rohstoffe werden in der öffentlichen Debatte zunehmend kritisiert. Der Naturschutz beklagt zunehmende Belastungen des Naturhaushaltes und die Landwirtschaft fürchtet Flächenkonkurrenzen und steigende Pachtpreise. Die Politik ist sich allerdings einig: Die Biomassebereitstellung soll auch zukünftig integraler Bestandteil von Ländlichen Entwicklungskonzepten sein. Damit die Biomassebereitstellung möglichst nachhaltig und naturverträglich erfolgen kann, sind neue Wege gefragt, um aus Sicht des Naturschutzes die Risiken weiter zu minimieren und mögliche Synergien zu fördern. Der Vortrag thematisiert wesentliche naturschutzpolitische Aspekte, die für eine naturverträgliche Biomassestrategie zu integrieren sind.

a) Konflikte/Risiken der Biomassebereitstellung
b) Anforderungen an eine nachhaltige Biomassestrategie aus Sicht des Naturschutzes
c) „Best Practice“ Beispiele für Synergien zwischen Naturschutz und Bioenergieerzeugung
d) Entwicklung von Naturschutzstandards für die Bioenergienutzung
e) Ansätze zur Steuerung des Energiepflanzenanbaus

"100 fields for diversity" – a new network for conserving arable wild plants in Germany

Stefan Meyer (1), T. van Elsen (2), K. Wesche (1) & C. Leuschner (1)*
(1) Albrecht-von-Haller-Institute for Plant Sciences, Department of Plant Ecology and Ecosystems Research, University of Goettingen, Untere Karspuele 2
D-37073 Goettingen, Germany
(2) Research Institute of Organic Agriculture (FiBL), Nordbahnhofstraße 1a, D- 37213 Witzenhausen
**smeyer1@gwdg.de*

Biodiversity in agricultural systems has become a central issue not only in the discussion of human impact on the environment, but also in terms of human dependence on ecosystem services. Since the 1950's, changes in agricultural land use have been particularly pronounced - increases in mean field sizes, in the use of pesticides and fertilizers are well-known examples. Losses of diversity in central Europe have been most pronounced in agricultural systems, and current developments such as the introduction of genetically modified crops and the increasing use of biofuels may accelerate this development.

The flora of central Europe comprises some 350 species that occur primarily on agricultural fields, but truly species-rich acres have become rare in the current landscape. Approximately every second species is *threatened*, according to current Red List criteria, and conservation projects have focused on arable plants for over five decades. However, many of the particularly successful programmes of the 1980's have now ceased; and most field flora reserves of the former GDR lost their protection status following reunification. Except for a very few examples, such as *Bromus grossus*, arable plants have also not benefited from conservation efforts in the context of the European Union's Habitats Directive. As a consequence, the conservation status of many weeds has declined in the last decade.

This presentation provides an overview of the new project "100 fields of biodiversity". It aims at closing the gap in conservation of field wild plants by establishing a new network of reserves that are specifically dedicated to the conservation of agricultural biodiversity. In the feasibility study financed by the German *Deutsche Bundesstiftung Umwelt* (DBU), potential sites are selected and strategies are developed for proper management and long-term financial support. Particular emphasis is placed on close cooperation with local farmers and on individually tailored solutions. Farmers are asked to reduce intensity of land use on selected fields and refrain especially from using herbicides. At the same time, fields should not be left fallow for extended periods of time, ensuring a more or less continuous land use of at most moderate intensity (Fig. 1).

Figure 1: Comparison of a "Schutzacker" - maintained with project sources - with neighbouring dry calcareous grasslands and an intensely used field.

Short rotation coppice and its effects on biodiversity in Northern Germany (NOVALIS)

Franz Kroiher (2), Ulrich Schulz (1), Judith Bielefeld (2), Andreas Bolte (2)
(1) University of Applied Science Eberswalde, Faculty of Landscape Management and Nature Conservation, Friedrich Ebert Str. 28, 16225 Eberswalde, Germany
(2) Johann Heinrich v. Thünen-Institut, Institute of Forest Ecology and Forest Inventory, A.-Möller-Str. 1, 16225 Eberswalde, Germany

The cultivation of biomass for energy production is gaining in importance in Germany. Wood for energy production from short rotation coppice (SRC) of poplar and willow clones on fallow grounds may contribute significantly. In Germany, few studies of biological diversity in such plantations have been published, and, consequently, little is known about the habitat potential of different short rotation coppice patches. The NOVALIS project, funded by the Deutsche Bundesstiftung Umwelt (DBU) and co-ordinated by the Forest Ecosystem Research Centre of Göttingen University, aims to evaluate the ecological effects of SRC, and develop environmentally sound guidelines for selecting, designing and managing SRCs on agricultural land. This presentation deals with the diversity of different plant and animal taxa, and with habitat structures typically found in SRCs.

A census of all **breeding birds** in three SRC stands in northern Germany was conducted in 2007. Here, these data are discussed in relation to the habitat structures identified. In one SRC in Hesse (Germany), the breeding bird communities already had been investigated in 1994 and 1998. Therefore, it was possible to detect long-term changes in habitat structures and breeding bird communities. There was a significant change in the number of bird species, bird species composition and breeding bird density. The number of breeding bird species increased from 15 to 20, and the overall density of territories doubled from 19.7 up to 39.3 territories/10 ha.

Furthermore different groups of **insects** were monitored on four SRCs in 2007 and 2008. Ground beetles (Carabidae), orthopteroid insects (Ensifera and Caelifera), butterflies (Rhopalocera and Zygaenidae) and leafhoppers (Auchenorrhyncha) were compared on SRC stands and adjacent habitats. The importance of habitats like hedgerows and shrubs surrounding and within SRC is discussed.

The **phytodiversity** assessment focussed on the influence of spatial scale on species richness in SRC stands. The abundance, and mean shoot length of vascular plants in seven poplar SRC stands was recorded at the plot (11 m² surface), and stand or patch level (1,600 m² surface) using a nested grid design. Finally, inventories of plant species occurrence were undertaken in adjacent areas of varying land use (MPP: multi-patch plots). Species composition at the landscape level (25 km² area), derived from the national floristic vegetation mapping, formed the reference for evaluations of standardized species richness in SRC stands. Species richness and species-area relationships are influenced by stand age and site conditions, indicating more homogeneous, but species-poorer compositions in older SRC stands with lower nutrition status. Compared to alternative land-uses, any decrease in plant species richness observed in SRC stands was minor. Results of additional analyses of patch vs. multi-patch perspective also are presented.

Poster presentations

Beitrag von Flächenpools zur Umsetzung von Biotopverbundkonzepten

Klaus Meier & Alica Tschierschke
Helmholtz Centre for Environmental Research – UFZ, Department of Conservation Biology, Permoserstr. 15, D-04318 Leipzig, Germany

Ein Drittel der Fläche des Südraumes Leipzig ist durch den Bergbau geprägt, dessen Einfluss reicht weit über diese Fläche hinaus. Mit seinen für den Arten- und Biotopschutz wertvollen, aber meist nicht gesicherten Flächen ist das Gebiet gleichzeitig ein wichtiger Teil der landesweiten Biotopverbundkonzeption in Sachsen.

Der Südraum Leipzig ist prädestiniert für eine regionale Weiterentwicklung des landesweiten Biotopverbunds, da schon ein Zielartenkonzept für einen Teil der Kernflächen, nämlich für die naturschutzfachlich wertvollen Flächen der Bergbaufolgelandschaft, besteht.

Zur Verwirklichung des landesweiten Biotopverbundkonzeptes fehlen jedoch detaillierte, fachliche Begründungen und Instrumente zur Umsetzung auf der unteren Planungsebene. Ein viel versprechendes Instrument bei der Umsetzung von Biotopverbundmaßnahmen können Ausgleichs- und Ersatzmaßnahmen sein. Diese Maßnahmen müssen, um als Biotopverbundmaßnahmen im Sinne des § 3 BNatSchG anerkannt zu werden, auf Flächen liegen, die, vor dem Hintergrund einer Bedarfsermittlung und unter Berücksichtigung formulierter Entwicklungsziele, als Gebiete mit Entwicklungspotenzial im Sinne des Biotopverbundes identifiziert wurden.

Eine im Rahmen des DBU-Forschungsprojektes ReNat (Regionales Naturschutznetz) angefertigte Masterarbeit beschäftigte sich mit der Frage, welchen konkreten Beitrag Kompensationsflächenpools zur Umsetzung von Biotopverbundkonzepten leisten können. Grundlage war die umfassende Ermittlung des Handlungsbedarfes beim Biotopverbund im Südraum Leipzig durch die Auswertung relevanter Fachplanungen. Dazu zählen das landesweite Biotopverbundkonzept, der Regionalplan des Regierungsbezirkes Westsachsen, Braunkohlepläne, die Hochwasserschutzkonzepte der Pleiße und der Weißen Elster, Informationen über „Natura 2000“-Gebiete im Südraum und Daten eines wissenschaftlich begründeten Vorrangflächennetzes. Die Ermittlung des Handlungsbedarfes mündete in einer Liste für die Umsetzung eines Biotopverbunds im Südraum Leipzig notwendiger Maßnahmen(-typen) und wurde kartografisch dargestellt.

Der Beitrag zum Biotopverbund wurde einerseits flächenbezogen auf die unmittelbar im Zentrum naturschutzfachlich wertvoller Gebiete liegenden Fokusgebiete des Forschungsprojektes ermittelt. Andererseits wurde auf die überregionale Wirkung möglicher Biotopverbundmaßnahmen eingegangen. In der Diskussion wird verbal-argumentativ bewertet, welche der geplanten Maßnahmen der potenziellen Flächenpools,in welchem Maße der Umsetzung des Biotopverbunds dienen und im Rahmen von Kompensationsflächenpools umsetzbar sind. Aus diesen Aussagen lassen sich allgemeine Schlussfolgerungen zum möglichen Beitrag von Flächenpools zu Biotopverbundkonzepten ableiten.

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