Owen Lewis: **Trophic interactions and tropical tree diversity**

Evidence is accumulating that the structure and diversity of plant communities in a variety of ecosystems can be profoundly influenced by interactions with their natural enemies, such as pathogens and herbivores. In tropical forests, density-dependent or distance-dependent 'pest pressure' (sometimes called 'Janzen-Connell' or 'feedback' effects) is a leading explanation for the maintenance of trophically unspecialized but extremely species-rich plant assemblages. Analyses of patterns of plant survival and growth from permanent census plots throughout the tropics show the signature of such effects: plants perform well where they are at low density, but more poorly at higher densities. I will describe our experimental work investigating the mechanisms underlying these patterns, attempting to (i) identify the natural enemies responsible for density dependence; (ii) quantify the functional relationship between density and diversity; and (iii) investigate the causal link between natural enemies and plant diversity. Our experiments reveal a key role for insect seed predators and (to a lesser extent) fungal pathogens. The degree of host-specificity of plant natural enemies is a key parameter for understanding their community-wide consequences, and I consider how host-specificity can best be quantified for fungal pathogens and insect herbivores. Finally, I discuss how pervasive anthropogenic environmental change (such as climate change and exploitation of forests) may alter trophic interactions, with potentially important implications for the structure, composition and diversity of ecological communities.

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Bagchi, R., C. D. Philipson, et al. (2011). Impacts of logging on density dependent predation of dipterocarp seeds in a Southeast Asian rainforest. Philosophical Transactions of the Royal Society B-Biological Sciences, in press.

Freckleton, R. P. and O. T. Lewis (2006). Pathogens, density dependence and the coexistence of tropical trees. Proceedings of the Royal Society B-Biological Sciences 273: 2909-2916.

Lewis, O. T. and S. Gripenberg (2008). Insect seed predators and environmental change. Journal of Applied Ecology 45: 1593-1159.

Christian Mulder: **Elemental fluxes and productivity**

P-rich grasslands are supportive of larger soil invertebrates. In fact, the relative abundances of different invertebrates, bacterial cells and fungi are strongly correlated with the carbon-to-phosphorus ratio. In Dutch natural soils lacking in phosphorus, bacterial cells are expected to grow more slowly and to have lower phosphorus contents. This might limit the quality of the microbial resource for other organisms higher up the food web (and consequently their development) that feed on bacterial cells, like most nematodes. Overall, the binned abundance of the body sizes of invertebrates is closely related to the molar ratios of carbon, nitrogen and phosphorus, and to soil acidity. The higher the level of “available” phosphorus (and the lower the soil acidity), the greater the population density of larger invertebrates. Conversely, when phosphorus levels were limited (like in the more acidic soils under heathlands), there were comparatively fewer larger-sized invertebrates but much more smaller-sized invertebrates. This suggests that smaller-bodied invertebrates cope better with nutrient-poor conditions, in which phosphorus is limited, than larger-bodied invertebrates, such as microarthropods.

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Mulder, C., BOIT, A., BONKOWSKI, M., DE RUITER, P.C., MANCINELLI, G., VAN DER HEIJDEN, M.G.A. VAN WIJNEN, H.J., VONK, J.A., RUTGERS, M., 2011. A belowground perspective on Dutch agroecosystems: How soil organisms interact to support ecosystem services. – Advances in Ecological Research 44 (ISBN:9780123747945).

Christoph Scherber: **Effects on plant species richness on multitrophic interactions: Results from an eight-year biodiversity experiment**

Plant biodiversity has been shown to influence ecosystem processes such as plant productivity, nutrient dynamics or biological invasions. However, plant species richness effects on multitrophic interactions are largely unexplored. Using data from a large biodiversity experiment collected over eight years, I show that plant species richness significantly affects a wide range of organisms and their interactions. In particular, I show that herbivore diversity and abundance are more strongly linked to plant species richness than carnivores or omnivores. Plant biodiversity effects are consistent above- and belowground. I provide a unifying model that may help understand the effects of plant biodiversity on multitrophic interactions. The findings presented in this talk may have implications for other systems, e.g. agricultural land, and ecosystem services such as biocontrol.

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Haddad, N. M., G. M. Crutsinger, et al. (2009). "Plant species loss decreases arthropod diversity and shifts trophic structure." Ecology Letters 12(10): 1029-1039.

Hooper, D. U., F. S. Chapin, et al. (2005). "Effects of biodiversity on ecosystem functioning: a consensus of current knowledge." Ecological Monographs 75(1): 3-35.

Scherber, C., N. Eisenhauer, et al. (2010). "Bottom-up effects of plant diversity on multitrophic interactions in a biodiversity experiment." Nature 468(7323): 553-556.

Ulrich Brose: **Extinctions in complex ecological networks**

Recent evidence suggests that the global ecosystems are currently exposed to a wave of species' extinctions. In this context, addressing the consequences of species extinctions for natural ecosystems has become one of the most urgent scientific questions. Dynamic models of complex networks with allometric scaling of population parameters offer a tool for analysing the long-term and large-scale consequences of species loss. More specifically, this presentation will demonstrate how network approaches can address the following questions: (1) what determines species' vulnerabilities to primary extinction, (2) how can we predict short-term biomass effects of species loss, and (3) what is driving the susceptibility to secondary extinctions.

Riede, J.O., Brose, U., Ebenman, B., Jacob, U., Thompson, R., Townsend, C.R., & Jonsson, T. (2011): Stepping in Elton's footprints: a general scaling model for body masses and trophic levels across ecosystems. Ecology Letters, 14 (2): 169-178.

Brose, U. (2010): Improving nature conservancy strategies by ecological network theory. Basic and Applied Ecology 11: 1-5.

Brose, U. (2010): Body-mass constraints on foraging behaviour determine population and food-web dynamics. Functional Ecology 24: 28-34.

Berlow, E.L., Dunne, J.A., Martinez, N.D., Stark, P.B., Williams, R.J. & Brose, U. (2009): Simple prediction of interaction strengths in complex food webs. PNAS 106: 187-191.

Peter C. de Ruiter: **Food web complexity and stability: the role of energetics**

Food webs bring structure to the ecosystems of our planet by disentangling the complex networks of feeding relations between species (‘who eats whom’). Understanding how stability emerges from complexity in such trophic networks, how robust these networks are, and what the consequences are for biodiversity and energy flow in ecosystems, touches on the most central problems in ecology.

The well-known theoretical findings of May (1973) indicates that complexity constraints stability. This challenges the generally accepted notion at that time that biological diversity enhances stability (McArthur 1955). Motivated by May (1973), many theoretical and empirical studies have been carried out to clarify the relationship between complexity and stability in food webs. Simultaneously, the study on flow of energy and matter in food webs gained momentum as integral part of systems ecology (e.g. Odum 1972, DeAngelis 1992). Since then, the food web approach has been adopted to analyse interrelationships between food web complexity, stability and ecosystem processes (Polis & Winemiller 1996, De Ruiter et al. 2005).

In this presentation I will discuss the inextricably relationship between food web structure, stability and functioning. The central idea is that community structure and ecosystem productivity should be ‘in balance’ in order to achieve food web stability. I will use a few well-parameterized soil food webs as a starting point, in order to come to more general conclusions about the role of energy flow in stabilising complex food webs.

DeAngelis D.L. (1992) Dynamics of nutrient cycling and food webs. Chapman & Hall, London.

De Ruiter P.C., Wolters, V. & Moore, J.C. (2005): Dynamic Food Webs. Academic Press

MacArthur R. 1955 Fluctuation of animal populations, and a measure of community stability. Ecology 36, 533-536

May R.M.: Stability and complexity in model ecosystems. Princeton University Press, 1973

Odum, E.P. (1971) Fundamentals of Ecology, 3nd edition Saunders, Philadelphia, USA.

Polis, G.A. & Winemiller, K.O (1996). Food webs: integration of patterns and dynamics. Chapman & Hall, New York.

Alastair Fitter: **Arbuscular mycorrhizal fungi: key regulators of nutrient cycles**

Mycorrhizal fungi have generally been viewed as a symbiosis important in plant phosphate nutrition, but their role in other element cycles has been underestimated. Based on a model for the regulation of nutrient fluxes at the fungus-plant interface, I shall show that they are a major component of the nitrogen cycle and use N as well as P as an agent to induce carbon flux from the plant. One consequence of this perspective is that knowledge of the biology of the fungal mycelium in soil is both necessary and inadequate, although there is increasing evidence that both the evolutionary dynamics of AM fungi and the structure of AM fungal communities is determined more by soil factors than by the plant community.

Leigh J, Fitter AH, Hodge A (2011). Growth and symbiotic effectiveness of an arbuscular mycorrhizal fungus in organic matter in competition with soil bacteria. FEMS Microbiology Ecology 76: 428-438.

Fitter AH, Helgason T, Hodge A (2011). Nutritional exchanges in the arbuscular mycorrhizal symbiosis: implications for sustainable agriculture. Fungal Biology Reviews 25:1-5.

Dumbrell AJ, Ashton PD, Aziz N, Feng G, Nelson M, Dytham C, Fitter AH, Helgason T (2011). Distinct seasonal assemblages of arbuscular mycorrhizal fungi revealed by massively parallel pyrosequencing. New Phytologist 190:794-804.

Fitter AH, Helgason T, Hodge A (2010). Nutritional ecology of arbuscular mycorrhizal fungi. Fungal Ecology 3: 267-273.

Hodge A, Fitter AH (2010). Substantial nitrogen acquisition by arbuscular mycorrhizal fungi from organic material has implications for N cycling. PNAS 107: 13754-13759.

Dumbrell AJ, Nelson M, Helgason T, Dytham C, Fitter AH (2010) Idiosyncrasy and overdominance in the structure of natural communities of arbuscular mycorrhizal fungi: role of stochastic processes. Journal of Ecology 98: 419-428.

Alexandre Jousset: **Allelopathy and resource competition link diversity and ecosystem service in microbial communities**

Biodiversity is a major determinant of ecosystem performance. Numerous studies demonstrated a positive diversity - productivity relationship due to complementary resource use. However, organisms within a community are also competing for resources, and many species directly inhibit competitors by producing toxins. I will discuss the effects of species richness on direct (allelopathy) and indirect (resource based) competition, and link these effects to microbial community performance. Increased allelopathy at high species richness reduces the productivity and ecosystem service of diverse communities. On the other side, resource specialization of species promotes productivity at high diversity by improving resource uptake. Both resource use and toxin production represent key determinants of community performance and invisibility, as well as the stability of social behavior. I suggest that integration of both of these interactions is necessary to fully appreciate the role of diversity for ecosystem functioning.

Cadotte, M. W., Cardinale, B. J. & Oakley, T. H. Evolutionary history and the effect of biodiversity on plant productivity. Proc. Natl. Acad. Sci. U. S. A. 105, 17012-17017

Cardinale, B. J. Biodiversity improves water quality through niche partitioning. Nature 472, 86-89 (2011).

Hibbing, M. E., Fuqua, C., Parsek, M. R. & Peterson, S. B. Bacterial competition: surviving and thriving in the microbial jungle. Nat. Rev. Microbiol. 8, 15- 25 (2010).

Jousset, A., Schmid, B., Scheu, S. & Eisenhauer, N. Genotypic richness and dissimilarity opposingly affect ecosystem performance. Ecol. Lett. 14, 537- 624

Jousset, A., Schulz, W., Scheu, S. & Eisenhauer, N. Intraspecific genetic richness and relatedness predict the invasibility of bacterial communities ISME J. in press (2011).

Maaria Rosenkranz: **Isoprene and co. - multiple functions in plants**

Plants interact with their environment by the emission of a great variety of volatile organic compounds (VOCs), terpenes (≡ isoprenoids), i.e. isoprene, mono-, homo-, and sesquiterpenes, being the most prominent group. All together, global terpene emissions to atmosphere by plants amount to approximately 1150 Tg C y-1 (Guenther et al., 1995). In the atmosphere terpenes react rapidly with reactive oxygen and nitrogen species, and contribute to climate change and air pollution by enhancing e.g. the secondary organic aerosol formation, the lifetime of methane or the concentration of tropospheric ozone (Lerdau, 2007; Thompson, 1992; Clays et al., 2004).

Isoprene is the simplest terpene (C5-compound), whose main source tree species like poplars and oaks contribute by 75% to the global annual isoprene emission of 500 Tg C y-1. For trees themselves actual studies indicate that isoprene can enhance the plants tolerance against abiotic stresses, like high temperature (Sharkey and Singsaas, 1995; Behnke et al., 2007, 2010) or oxidative stress (Loreto and Velikova, 2001), but the underlying mechanisms are not yet elucidated (Loreto and Schnitzler, 2010). Our studies with transgenic non-isoprene emitting poplars showed for first time that wild type plants did recover better from transient and moderate temperature stress than the non-isoprene emitting plants (Behnke et al., 2007, 2010; Way et al. 2011). The result suggests that isoprene would protect rather against transient thermal stress than against a permanent high temperature.

Other terpenes, especially sesquiterpenes and homoterpenes have often been shown to have a signaling nature between plants and their environment. The activation of the plants' signaling network due to insect attack induces a plant and herbivore species-specific blend of volatiles that can mediate plant defense by repelling herbivores and attracting carnivorous arthropods (Pichersky and Gershenzon, 2002; Degenhardt et al., 2003). Very recently two independent reports showed that also isoprene can be recognized by insects and that it can change their behaviour (Loivamäki et al., 2008; Laothawonkitkul et al., 2008) Own work (Loivamäki et al., 2008) on transgenic isoprene-emitting Arabidopsis shows that parasitic wasps, that can defend plants against herbivores (Van Poecke et al., 2001), are repelled by isoprene. How common is isoprene recognition under natural situations and which importance it might play in the environment needs urgently to be elucidated.

Behnke et al. (2007) Plant J 51: 485-499
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Loivamäki et al. (2008) PNAS 105: 17430-17435
Loivamäki et al. (2007) Plant Phys 144: 1066-1078
Claeys et al. (2004) Science 303: 1173-1176
Degenhardt et al. (2003) Curr Opin Biotechnol 14: 169-176
Guenther et al. (1995) J Geophys Res 100: 8873-8892
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Lerdau M (2007) Ecology 316: 212-213
Loreto and Schnitzler (2010) Trends in Plant Sci 15: 154-166
Loreto and Velikova (2001) Plant Physiol 127: 1781-1787
Pichersky and Gershenzon (2002) Curr Opin Plant Biol 5: 237-243
Sharkey and Singsaas (1995) Nature 374: 769
Thompson (1992) Science 256: 1157-1165

Van Poecke et al. (2001) J Chem Ecol 27: 1911-1928
Way et al. (2011) Oecologia 166 : 273-282

Richard Norby: **Forest Responses to Elevated CO2. Lessons from a decades-long research program**

Free-air CO2 enrichment (FACE) experiments have provided novel insights into the ecological mechanisms controlling the cycling and storage of carbon in terrestrial ecosystems and contribute to our ability to project how ecosystems respond to increasing CO2 in the Earth's atmosphere. Important lessons emerge by evaluating a set of hypotheses which initially guided the design and longevity of forested FACE experiments. Net primary productivity is increased by elevated CO2, but the response can diminish over time. Carbon accumulation is driven by the distribution of carbon among plant and soil components with differing turnover rates, and by interactions between the carbon and nitrogen cycles. Plant community structure may change, but elevated CO2 has only minor effects on microbial community structure. FACE results provide a strong foundation for next generation experiments in unexplored ecosystems and inform coupled climate-biogeochemical models of the ecological mechanisms controlling ecosystem response to the rising atmospheric CO2 concentration.

Norby RJ, Warren JM, Iversen CM, Medlyn BE, McMurtrie RE. 2010. CO2 enhancement of forest productivity constrained by limited nitrogen availability. Proceedings of the National Academy of Sciences 107: 19368-19373.
Iversen CM, Ledford J, Norby RJ. 2008. CO2 enrichment increases carbon and nitrogen input from fine roots in a deciduous forest. New Phytologist 179: 837-847.
Norby RJ, DeLucia EH, Gielen B, Calfapietra C, Giardina CP, King JS, Ledford J, McCarthy HR, Moore DJP, Ceulemans R, De Angelis P, Finzi AC, Karnosky DF, Kubiske ME, Lukac M, Pregitzer KS, Scarascia-Mugnozza GE, Schlesinger WH, Oren R. 2005. Forest response to elevated CO2 is conserved across a broad range of productivity. Proceedings of the National Academy of Sciences 102: 18052-18056.
Norby RJ, Ledford J, Reilly CD, Miller NE, O'Neill EG. 2004. Fine-root production dominates response of a deciduous forest to atmospheric CO2 enrichment. Proceedings of the National Academy of Sciences 101: 9689-9693.
Norby RJ, Wullschleger SD, Gunderson CA, Johnson DW, Ceulemans R. 1999. Tree responses to rising CO2: Implications for the future forest. Plant, Cell and Environment 22: 683-714.

Hans Pretzsch: **Productivity of mixed-species versus pure forest stands. From fact finding to understanding**

The focus is on the productivity of mixed versus pure forest stands. While the strong influence of agronomy on forest practice resulted in extended forest monocultures in the past, mixed-species stands receive more attention at present (Scherer-Lorenzen et al. 2005). The reason for this increasing interest is that close-to-nature mixed species stands are widely held to supply ecological, economical and socio-cultural forests goods and services in a similar or even better way as far-from-nature monocultures. A crucial question for the progress of the mixed stand matter is how the productivity of polycultures comes off compared with monocultures. Knowledge of the advantages or disadvantages of mixed versus pure stands with respect to productivity influences decisively the forest owners decision in favor or against mixed species stands.

First, long-term mixing experiments, with many of them under survey since the 1880s, are applied for indicating the extent of over- or underyielding of mixed versus pure stands.

The analysis is concentrated on the practically relevant mixtures of European beech (Fagus sylvatica L.) with Norway spruce (Picea abies (L.) H. Karst.) and European beech with Sessile oak (Quercus petraea (Mattuschka) Liebl.).

Second, the mixing reactions are analysed in dependence on site conditions. This analysis is based on experiments along a stress gradient reaching through Central Europe and covering poor as well as fertile sites. Poor sites where European beech facilitates spruce and oak can be distinguished from fertile sites where competition reduction or competition is prevailing.

Third, the mixing reactions are traced from the stand to the tree and organ level in order to explain the species-specific and site-dependent behaviour of spruce, beech and oak in mixture. The extent of crown plasticity under intra- and inter-specific competition turns out as relevant for the species-specific performance in mixture.

Based on the empirical findings a general pattern of mixing reactions, guidelines for practical applications, and conclusions for stand modelling are discussed. The presentation finishes with working hypotheses for further research.

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Richards AE, Forrester DI, Bauhus J, Scherer-Lorenzen M (2010) The influence of mixed tree plantations on the nutrition of individual species: a review, Tree Physiology, DOI:10.1093/treephys/tpq035.

Scherer-Lorenzen M, Körner C, Schulze E-D (2005) Forest diversity and function. Ecol Studies 176, Springer-Verlag, Berlin, Heidelberg, 399 p

Vandermeer, J. (1989) The ecology of intercropping, Cambridge University Press, UK, 237 p.

Alexander Knohl: **Carbon, water and energy fluxes between terrestrial ecosystems and the atmosphere**

Plants are important mediators of water and carbon transport along the soil-plant-atmosphere interface and thus modulate the atmosphere energy and chemical composition. While a number of studies have shown the impact of differences in land-use on biosphere-atmosphere feedbacks, much less is known about the relevance of individual plant species within land-use types on such feedbacks. The global Fluxnet network of towers measuring CO2, water and energy fluxes between terrestrial ecosystems and the atmosphere provides a unique database to investigate the relevance of biodiversity for ecosystem scale carbon, water and energy fluxes, but have yet not been explored. In this presentation I will to discuss opportunities and challenges of linking biodiversity to ecosystem scale fluxes.

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Baldocchi, DD 2008. 'Breathing' of the Terrestrial Biosphere: Lessons Learned from a Global Network of Carbon Dioxide Flux Measurement Systems. Australian Journal of Botany. 56, 1-26.

Andrew Hector: **The Diversity Debate: Evolving Paradigms in Biodiversity Science**

Once upon a time ecologists believed that diversity was controlled by productivity in the form of a unimodal 'hump-backed' relationship. More recently, ecologists have identified a 'biotic feedback' and the paradigm has developed into a two-way relationship between diversity and productivity. I shall review recent progress in both areas and present some new results.

Bradley J. Cardinale, Kristin L. Matulich, David U. Hooper, Jarrett E. Byrnes, Emmett Duffy, Lars Gamfeldt, Patricia Balvanera, Mary I. O'Connor, and a. A. Gonzalez. 2011. The functional role of producer diversity in ecosystems. Am. J. Botany.

Cardinale, B. J. 2011. Biodiversity improves water quality through niche partitioning. Nature.

Gravel, D. et al. 2011. Experimental niche evolution alters the strength of the diversity–productivity relationship Nature.

Mora C, Aburto-Oropeza O, Ayala Bocos A, Ayotte PM, Banks S, et al. (2011) Global Human Footprint on the Linkage between Biodiversity and Ecosystem Functioning in Reef Fishes. PLoS Biol 9(4): e1000606. doi:10.1371/journal.pbio.1000606.

Mary Firestone: **How will expanding molecular characterization of soil microbial communities advance our understanding of terrestrial ecosystem function?**

Analysis of indigenous soil microbial communities has traditionally been limited by inability to identify prokaryotic populations actively involved in mediating ecosystem processes. Rapid expansion of technology for molecular analysis of complex soil communities now enables microbial ecologists to more comprehensively describe microbial communities; but does it allow us to find the key players and better understand their functions? Two case studies using molecular characterization of soil prokaryotic communities demonstrate current potentials and limitations of soil microbial community analysis: one based on 16S RNA and the other on functional genes and their transcripts. One investigation addresses prokaryotic community assembly; trajectories of indigenous assemblages receiving carbon augmentation were followed using high density microarray analyses. Independent of the amount or type of carbon supplied, community composition converged over a period of about 300 days. In a second study, the first rainfall following a long dry period in a semi-arid ecosystem provided a large, abrupt change in the water potential that was a severe physiological stress and/or a defined stimulus for the reawakening of soil microbial communities rendered inactive by low-water conditions. The responses of indigenous communities were followed by high density microarray analyses of both DNA and RNA for 16S rRNA and quantification of transcripts for specific functions. After months of desiccation-induced inactivation, we found a range of transcriptional responses to wet up indicating a diversity of phylogenetically-clustered response strategies.

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DeAngelis KM, Silver WL, Thompson AW, Firestone MK (2010). Microbial communities acclimate to recurring changes in soil redox potential status. Environ Microbiol 12: 3137-3149.

Brodie EL, Desantis TZ, Joyner DC, Baek SM, Larsen JT, Andersen GL et al (2006). Application of a high-density oligonucleotide microarray approach to study bacterial population dynamics during uranium reduction and reoxidation. Appl Environ Microbiol 72: 6288-6298.

Kieft TL, Soroker E, Firestone MK (1987). Microbial Biomass Response to a Rapid Increase in Water Potential When Dry Soil Is Wetted. Soil Biology & Biochemistry 19: 119-126.

Rodica Pena: **Effects of carbon limitation on beech (Fagus sylvatica) ectomycorrhizal fungal community structure**

In temperate and boreal forest ecosystems, most tree species form ectomycorrhizal (EM) fungal associations. EM fungal species display characteristic morphological and functional varieties, especially with regard to root weathering capacity, development of external mycelia - soil exploration type, or capacities for carbon uptake. In contrast with free-living soil microorganisms, they have direct access to reduced carbon from their plant partner.

We studied the relationships between plant carbon resources, soil carbon and nitrogen content, and EM fungal diversity in a beech forest by manipulating carbon flux by stem girdling. We hypothesized that suppressing of carbon supply would not affect diversity and EM fungal species numbers if EM fungi can access plant internal carbohydrate resources, or it would result in a selective disappearance of EM fungal taxa due to differences in carbon demand of different fungi. Tree carbohydrate status, root demography, EM colonization, and EM fungal species abundance were measured repeatedly during 1 year after girdling. Girdling did not affect root colonization but strongly decreased EM fungal species richness. Mainly cryptic EMF species disappeared. Shannon-Wiener index decreased with glucose, fructose, and starch concentrations of fine roots. Our results suggest that beech maintains numerous rare EM fungal species by recent photosynthate. These EM fungi may constitute biological insurance for adaptation to changing environmental conditions. We are grateful to German Research Foundation (DFG) for financial support.

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Jürgen Homeier: **Tree species richness, carbon storage and productivity of Ecuadorian tropical forests**

This study explores the relationships between tree species richness and measures of carbon storage and forest productivity comparing two altitudinal transects in Ecuadorian tropical forests. Species richness and productivity are two fundamental properties of ecosystems and both have implications for their stability and functionality. SRPRs (species richness - productivity relationships) have long been a subject of interest of ecologists and a further understanding is essential in the light of increasing deforestation and habitat loss in tropical forests. Most studies on SRPRs were carried out in grasslands, temperate forest systems or in forest plantations so far and data from old-growth forests are still scarce, particularly for species-rich tropical forests the relationships between biomass, productivity and tree species richness on the one hand and environmental determinants on the other hand are not well understood.

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Keeling, H.C. & Phillips, O.L. (2007) The global relationship between forest productivity and biomass. Global Ecol. Biogeogr. 16: 618-631.

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Phillips, O.L., Hall, P., Gentry, A.H., Sawyer, S.A. & Vásquez, R. (1994) Dynamics and species richness of tropical rain forests. PNAS 91: 2805-2809.

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Louise Jackson: **Agricultural land use, soil biota and ecosystem services**

Agricultural systems must become more productive to meet world food demand, but this must occur in a way that also supports environmental quality, rural livelihoods and biodiversity conservation. Ecological intensification of agriculture can be defined as greater reliance on ecological processes and less dependence on non-renewable inputs (e.g. synthetic fertilizers, pesticides, and fossil fuels), with the aim of increasing the set of multiple ecosystem services in an agricultural landscape. This requires commodity-specific, soil-specific and regional planning to cope with ecosystem heterogeneity and socioeconomic frameworks. Using California agroecosystems as examples, this talk will consider approaches for studying the ecological functions that result from higher plant and soil biodiversity, and in structuring research so that it can best inform decision-making and policy to increase ecosystem services.

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Ivette Perfecto: **Biodiversity and Autonomous Pest Control in the Coffee Agroecosystem**

It has been argued that biodiversity contributes important ecosystem services to agriculture. Among the ecosystem services that have received some attention in the ecological and agronomic literature is the service of pest regulation. In this presentation I will review the evidence that biodiversity contributes to pest regulation in agroecosystems and will examine some of the mechanisms that lead to pest reduction. In the second part I will present an example of how series of complex ecological interactions surrounding a keystone mutualistic system result in the regulation of several pest species in a coffee agroecosystem.

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Nicole Wrage: **Phytodiversity, resource use and production in agricultural grasslands**

Phytodiversity has been suggested to improve grassland productivity. Investigations in experimental grassland plots have indicated several mechanisms for this improvement, e.g. complementary resource use, smaller inter- than intraspecific competition or different optimum conditions of coexisting species, leading to better resilience of multispecies swards. However, the experience of farmers has shown that for optimizing herbage yield and quality, few very productive and highly digestible species should be established and invading less valuable species should be removed. In this presentation, I want to investigate reasons for these discrepancies between experimental results and farmers' knowledge. Using results from experiments carried out on agricultural grassland, I will address the following main questions: Does phytodiversity influence the use of water and nutrients in permanent agricultural grassland? How does this affect the quantity and quality of agricultural grassland production?

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Kilian Bizer: **Biodiversity loss, land use change and regulatory impact assessments**

Land use change is a major direct driver of change in biodiversity and ecosystem loss (MA 2005). The ongoing conversion of open space to housing and infrastructure purposes exacerbates habitat and species loss. While this doubtlessly creates an urgent need for planners to address land use change by saving open space on a regional and local level, it also involves a regulatory choice problem as the Federal Government should present policy instruments capable of meeting their 30-ha-per-day-objective for the conversion of open space to housing, industry and traffic purposes.

For the Federal Government possible policy instruments could be additional planning schemes or economic instruments such as charges (Bizer 2005) or tradable planning permits (Henger/Bizer 2010). The diversity of instrumental alternatives poses a regulatory choice problem which should be solved by conducting regulatory impact assessments comparing these alternatives. Such impact assessments are widely introduced within OECD countries and the EU (Radaelli/Francesco 2005). But they face structural problems to assess environmental impacts as well as institutional obstacles. The presentation discusses the current practice of impact assessments and their shortcomings and shows the crucial role of transparency in order to improve quality of impact assessments.

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Andreas Lüscher: **Benefits and limits of sward diversity for fertile multifunctional grassland**

Multifunctionality is a central aim of modern grassland management. So far, many experiments performed on nutrient-poor grassland have shown a positive relationship between plant species richness and ecosystem functioning. Recent evidence suggests that even a moderate increase in species richness can result in large effects on different ecosystem functions also under fertile conditions. A pan-European experiment carried out at 28 sites across climatic zones from Mediterranean to Arctic found that 4-species mixtures yielded more forage than even the best performing monoculture (transgressive overyielding). Mixtures strongly reduced the incidence of unsown species in the sward.

These diversity effects were consistent over the wide range of environmental conditions and persisted over three years, but were clearly reduced in highly N-fertilized conditions. Diversity effects were mainly related to N input by legumes trough their symbiotic N2 fixation. These results indicate a strong potential for agronomic mixtures to contribute to more sustainable and N-efficient agricultural systems. The question will be raised about the most appropriate strategy to improve resource efficiency and productivity in fertile grasslands: should it focus on simple or complex mixtures?

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David Kleijn: **Selling farmland biodiversity conservation in the face of growing demands for agricultural products - an advertiser's nightmare?**

The next few decades, conservation ecologists are facing critical challenges. In an era where the growing world population requires a doubling of agricultural productivity, we have to convince the public of the importance of biodiversity conservation. Conservation strategies should be effective yet not lower agricultural productivity unacceptably. Support by the general public for biodiversity conservation is pivotal. A popular approach these days is to highlight the importance of the services provided by natural ecosystems to mankind. However, with agriculture this may result in an apparent paradox. We would have to argue that increasing biodiversity will lead to increasing agricultural productivity, while at the same time the increasing agricultural productivity is one of the biggest threats to biodiversity. In this presentation I discuss strengths and limitations of the ecosystem services approach in an agricultural context. Can farmland biodiversity conservation be combined with high-yielding agriculture? Where and how should we mitigate biodiversity loss in agricultural landscapes? Can agricultural landscapes be redesigned to deliver ecosystem services even in intensive cropping systems?

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Christian Ammer: **Tree species diversity – a key issue of forest management in Central Europe**

Under natural conditions Central Europe would be covered by forests mainly dominated by European beech (Fagus sylvatica), a very shade tolerant species. On many sites beech forests were replaced by pure conifer forests some centuries ago. Thus, natural forests of low tree species diversity on the one hand and artificial pure conifer forest on the other hand, have been the main topic of forest management for many decades. Although forest scientists as for instance Cotta or Gayer stated as early as in the 19 century that mixed forests are advantageous compared to pure forests, it took another century until this idea became broadly accepted. For ecological (e. g. habitat diversity, decomposition, seepage water chemistry) and economical (portfolio theory) reasons, mixed stands are seen as a promising approach to fulfill present and future societal demands (Rothe et al. 2002, Ammer et al. 2008, Knoke et al. 2008, Jacob et al. 2010). However, because of the differing competitive ability of the various tree species, controlling a desired tree species composition over a whole rotation period is a challenging task, if silvicultural measures should be cost effective and mimicking natural processes. An effective tool for controlling tree species diversity, for example within the regeneration, is managing overstorey density by modifying resource availability (Wagner et al. 2009). Even though such approaches follow the so-called close-to nature-paradigm, it should be noted that maintaining high tree species diversity may be opposed to natural stand development.

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Yann Clough: **Combining high yields and high biodiversity in productive agricultural landscapes**

Local and landscape-scale agricultural intensification drives global biodiversity loss, and will continue to do so in future as global demand for agricultural commodities increases at an accelerating rate. Conserving biodiversity for its own sake and for its contribution to ecosystem functioning is necessary, but how to go about it? A controversy rages about the relative value of wildlife-friendly farming on the one hand, and combining high-intensity farming with land-sparing for nature on the other hand. I argue that the debate is to a significant extent artificial, and that both approaches are part of a continuum of landscape-wide approaches to land-use. Using yield and biodiversity data from temperate and tropical landscapes, as well as insights from published studies, I show that a differentiated approach according to the agroecosystems, priorities and the focus (global vs. local needs), rather than a dogmatic approach is necessary to move towards sustainable, biodiversity-friendly landscapes.

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John Vandermeer: **Land transformations, biodiversity, and social movements**

Recent controversies surrounding land use changes in the face of population pressure, concerns over greenhouse gas emissions and the challenges from rejuvenated social movements challenge the way we look at biodiversity responses to land transformations. Especially important is the reality of global interconnections that provide a new base on which understanding of these issues must be pursued.

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Vojtech Novotny: **Studying and preserving tropical biodiversity in Papua New Guinean rainforests**

Tropical forests are well known for their extraordinary species diversity. Even this diversity is dwarfed by the complexity of trophic interactions among species as every species interacts with many others in the rainforest ecosystem (Novotny et al. 2002). The science of food webs is at an exciting juncture as we are at last succeeding in detailed description of complicated rainforest food webs (Novotny et al. 2010) whilst also embarking on manipulative experiments, testing food web functional responses (Morris et al. 2004, Klimes et al. 2010). These developments are helped by rapid progress in molecular methods, aiding the detection of species and trophic interactions in the field as well as the interpretation of observed patterns in phylogenetic context. Many complex food webs in the tropics are being radically simplified by habitat conversion for agriculture and forestry. New Guinea is the largest tropical island, harboring one of the last three large and undisturbed tropical rainforests on the planet. Unusually, they are owned mostly by indigenous people belonging to over one thousand different tribes, each speaking their own language. The conservation of these forests is a challenge in some expected and many unexpected ways (Novotny 2010), as will be discussed in this lecture.

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