NAEM 2015

Netherlands Annual Ecology Meeting

10 & 11 February 2015

Congrescentrum De Werelt, Lunteren

- ***Programme***
- ***Presentation abstracts***
- ***Poster titles and numbers***
- ***List of participants***

Programme

Tuesday 10 February

	Main Entrance Hall			
08:30	Registration and coffee in the Lounge and setting up posters			
	Europe Hall			
10:15	**Word of Welcome** • Louise Vet (Chair of the Meeting, Netherlands Institute of Ecology) • Maurice Hoffmann (Chair NecoV, Research Institute for Nature and Forest)			
	Plenary 1: "Radical ideas and innovative tools in Ecology"			
10:30	1. **Zooming in to see the bigger picture: Microfluidic and nanofabrication tools to study ecology** (**Felix Hol**, Delft University of Technology)			
11.15	2. **Visualizing symbiotic trade** (**Toby Kiers**, Vrije Universiteit Amsterdam)			
12:00	**Lunch in the restaurant**			
	Europe Hall	**America Hall**	**Asia Hall**	**Africa Hall**
13:30	**Parallel 1a:** **Radical ideas and innovative tools in Ecology**	**Parallel 1b:** **Trait-based approaches in ecology**	**Parallel 1c:** **Spatial Ecology**	**Parallel 1d:** **Trophic Interactions**
	Conveners: 1. Toby Kiers (Vrije Universiteit Amsterdam) 2. Felix Hol (Delft University of Technology)	*Conveners*: 1. Dedmer B. van de Waal (Netherlands Institute of Ecology) 2. Marjolein Sterk (Wageningen University) 3. Maayke Stomp (University of Amsterdam)	*Conveners*: 1. Koen Siteur (Utrecht University) 2. Maria J.F. Santos (Utrecht University)	*Conveners*: 1. Liesbeth Bakker (Netherlands Institute of Ecology) 2. Maurice Hoffmann (Research Institute for Nature and Forest / Ghent University) 3. Chris Smit (University of Groningen)
13:30	eEcology, the solution to data intensive ecology (Willem Bouten, University of Amsterdam)	Understanding vegetation responses to environmental pressures using trait-based approaches (Peter van Bodegom, Leiden University)	Early life stages dictate the future: plant species sorting along moisture gradients (Rob Fraaije, Utrecht University)	Trophic interactions from a global change perspective (Liesbeth Bakker, Netherlands Institute of Ecology)
13:50	Science on the intersection of art and hacking (Pieter van Boheemen, Waag Society)	Interactive effects of bottom trawling and natural disturbance on benthic invertebrate community composition in soft-sediment habitats (Daniel van Denderen, IMARES)	Alternative stable states in a spatial context – a case study of Lake Taihu (Annette Janssen, Netherlands Institute of Ecology / Wageningen University)	Collapses of large piscivorous fish populations due to overfishing can be prevented and reversed by harvesting their prey (Floor Soudijn, University of Amsterdam)
14:10	Quantum Physics, Ecology and Evolution of Bacterial Nanowires (Carsten Blom, Delft University of Technology)	Bark trait dissimilarity determines soil fauna community composition (Juan Zuo, Vrije Universiteit Amsterdam)	Added biogenic structure enhances land-scape retention in a context-dependent way (Sil Nieuwhof, Royal Netherlands Institute for Sea Research)	Food web stability decreases prior to a critical transition in shallow lake ecosystems (Jan Kuiper, Netherlands Institute of Ecology)
14:30	Short Break			

	Parallel Session 1 Continued			
14:40	Muggenradar: sourcing the crowd for mosquito surveillance (Chantal Vogels, Wageningen University)	Competition for light and nutrients in layered communities of aquatic plants (Luuk van Gerven, Netherlands Institute of Ecology / Wageningen University)	Zooming in: spatial and temporal complexity in plant-soil feedback (Jasper Wubs, Netherlands Institute of Ecology / Wageningen University)	Interspecific plant interactions in response to the combined effects of drought and grazing pressure (Mart Verwijmeren, Utrecht University)
15:00	Quantitative imaging techniques to study carbon and nutrient flows (Matt Whiteside, Vrije Universiteit Amsterdam)	From plant phenolics to functions: the role of phylogeny and trade-offs (Bart Grutters, Netherlands Institute of Ecology)	Catching the wind: how experienced Honey Buzzards *Pernis apivorus* cope with sidewinds to complete long-distance soaring migration (Wouter Vansteelant, University of Amsterdam)	Parallel evolution in an invasive plant: How herbivore species affect competitive ability of *Jacobaea vulgaris* (Tiantian Lin, Leiden University)
15:20	Reproducible analytical workflows as efficient collaborative tools in microbial ecology (Leo Lahti, University of Helsinki / Wageningen University)	Effects of seed traits on the potential of seed dispersal by fishes with a contrasting feeding strategy (Ger Boedeltje, Radboud University Nijmegen)	Spatial structure of an individual-based plant-pollinator network (Melanie Hagen-Kissling, University of Amsterdam)	Gardening in the mud: Ragworms sprout cordgrass seeds for dinner (Zhenchang Zhu, Royal Netherlands Institute for Sea Research)
15:40	**Coffee and tea in the lounge**			
	Europe Hall	**America Hall**	**Asia Hall**	**Africa Hall**
16:00	**Parallel 2a: Eco-evolutionary possibilities and constraints in adjusting to rapid ecological changes**	**Parallel 2b: Ecological monitoring and environmental DNA**	**Parallel 2c: Disease Ecology**	**Parallel 2d: Carbon cycling: the importance of microbes**
	Conveners: 1. Christiaan Both (University of Groningen) 2. Phillip Gienapp (Netherlands Institute of Ecology)	*Conveners*: 1. Michiel Hootsmans (KWR Watercycle Research Institute) 2. Berry van der Hoorn (Naturalis Biodiversity Center)	*Conveners*: 1. Fred de Boer (Wageningen University) 2. Dieter Heylen (University of Antwerp) 3. Kevin Matson (University of Groningen) 4. Ellen Decaestecker (KU Leuven) 5. Bregje Wertheim (University of Groningen) 6. Tine Huyse (KU Leuven / Royal Museum for Central Africa)	*Conveners*: 1. Annelein Meisner (Lund University) 2. Ciska Veen (Netherlands Institute of Ecology)
16:00	Eco-evolutionary possibilities and constraints in adjusting to rapid ecological changes (Christiaan Both, University of Groningen, and Phillip Gienapp, Netherlands Institute of Ecology)	Monitoring biodiversity using environmental DNA (Philip Francis Thomsen, Natural History Museum of Denmark / University of Copenhagen)	A resource-based habitat approach for spatial modelling of vector-borne disease risks (Nienke Hartemink, Utrecht University)	Linking microbial ecology to soil carbon cycling (Annemieke van der Wal, Netherlands Institute of Ecology)
16:20	A genetic matrix population model for eco-evolutionary dynamics (Hal Caswell, University of Amsterdam)	Low pH and presence of organic matter reduce the amount of detectable environmental DNA in freshwater (Kees van Bochove, Naturalis Biodiversity Center / Wageningen University)	Surviving infection, the insect egg is able to defend itself against bacteria (Chris Jacobs, Leiden University)	Priming of soil organic matter and fungal ecology: is there a link? (Paolo Di Lonardo, Netherlands Institute of Ecology)

16:40	In the tropics a long-distance migrant pays the bill for Arctic warming (Jan van Gils, Royal Netherlands Institute for Sea Research)	Monitoring six fish species in a field study by environmental DNA detection using qPCR in comparison with trap catches (Bart Wullings, KWR Watercycle Research Institute)	*Ixodes ricinus* and *Borrelia burgdorferi* s.l. populations are maintained by a few common host species (Sanne Ruyts, Ghent University, and Tim Hofmeester, Wageningen University)	Negative priming effects of root decomposition by plant presence (Sigri Saar, Tartu University / Wageningen University)
17:00	Short Break			
17:10	Adapt, move or perish: how range shift can cause maladaptation (Marleen Cobben, Netherlands Institute of Ecology)	Monitoring fish using environmental DNA barcoding & metabarcoding (Jelger Herder, Reptile, Amphibian and Fish Conservation the Netherlands (RAVON))	Elemental changes along a temporal and spatial gradient: does it impact Daphnia - parasite interactions? (Lien Reyserhove, KU Leuven)	Fungal role in carbon flow in the rhizosphere along a chronosequence of abandoned agricultural soils (Emilia Hannula, Netherlands Institute of Ecology)
17:30	The role of dispersal and interspecific competition on local adaptation (Adriana Alzate, University of Groningen / Ghent University)	A new technique for detection of eDNA in water samples: a test on four aquatic species (Arjen de Groot, ALTERRA Wageningen UR)	Genetic variation in parasitoid resistance in natural populations of *Drosophila melanogaster* (Sylvia Gerritsma, University of Groningen)	Quantifying differential impacts of arbuscular and ectomycorrhizae on ecosystem carbon budget (Nadia Soudzilovskaia, Vrije Universiteit Amsterdam)
17:50	Rapid adaptation of herbivore consumers to nutrient limitation: eco-evolutionary feedbacks to population demography and resource control (Steven Declerck, Netherlands Institute of Ecology)	Second generation sequencing and morfological feacal analysis reveal unexpected foraging behaviour by the pond bat *(Myotis dasycneme)* (Anne-Jifke Haarsma, Naturalis Biodiversity Center / Radboud University Nijmegen)	Host specificity in ticks (Raoul van Oosten, University of Antwerp)	Climate warming alters communities of soil ascomycetes in arctic Alaskan tundra (Tatiana Semenova, Leiden University)
18:10	**Drinks in the Lounge and from 18:30 onwards dinner in the restaurant**			
19:30	**Poster session 1 (Odd-numbered posters are presented and discussed)**			
	Europe Hall			
21:00	**Evening Programme:** Menno Schilthuizen: Darwin's Peep Show – The Evolution of Animal Genitals *An evolutionary voyage through the amazing diversity of organs that animals use for their reproduction, and a portrait of a young and upcoming field in evolutionary biology. Brought to you, with many a naughty wink, by the author of the popular-science book Nature's Nether Regions (Penguin, 2014).*			

Wednesday 11 February

07:30	Breakfast in the restaurant			
08:00	Registration for those coming on Day 2 only			
	Europe Hall	**America Hall**	**Asia Hall**	**Africa Hall**
08:30	**Parallel 3a:** **Avian Population Studies**	**Parallel 3b:** **Recent advances in plant mycorrhizal research**	**Parallel 3c:** **Aquatic Ecology**	**Parallel 3d:** **Ecological Intensification of Agriculture**
	Conveners: 1. Eelke Jongejans (Radboud University Nijmegen) 2. Maja Roodbergen (Netherlands Institute of Ecology)	*Conveners*: 1. Hans Jacquemyn (KU Leuven) 2. Vincent Merckx (Naturalis Biodiversity Center)	*Conveners*: 1. Kees Musters (Leiden University) 2. Steven Declerck (Netherlands Institute of Ecology)	*Conveners*: 1. Willemien Geertsema (Wageningen University) 2. David Kleijn (Wageningen University / Alterra) 3. Paul van Rijn (University of Amsterdam)
08:30	Avian population studies in the Netherlands (Maja Roodbergen, Centre for Avian Population Studies)	Seedlings as empty islands: order of arrival structures arbuscular mycorrhizal colonisation of plants (Gijsbert Werner, Vrije Universiteit Amsterdam)	Aquatic metacommunity ecology: where are we and where do we go? (Steven Declerck, Netherlands Institute of Ecology)	Ecological intensification of agriculture: managing ecosystem services (Willemien Geertsema, Wageningen University)
08:50	Spatial demography of black-tailed godwits in a mosaic of traditional and modern agricultural landscape (Rosemarie Kentie, University of Groningen)	Warming enhances termination of a phytoplankton spring bloom: Impacts of fungal parasites (Thijs Frenken, Netherlands Institute of Ecology)	Land use effects on ditch ecosystem biodiversity among different species groups (Sven Teurlincx, Netherlands Institute of Ecology)	How complementary habitats can promote natural pest control (Paul van Rijn, University of Amsterdam)
09:10	Effects of nocturnal illumination on wild bird communities (Maaike de Jong, Netherlands Institute of Ecology)	Compositional shits in ectomycorrhizal fungal community in response to long-term snow depth manipulations (Luis Morgado, Naturalis Biodiversity Center)	Context-dependency of pesticide impacts on freshwater macrofauna community structures in ditches (Oleksandra Ieromina, Leiden University)	Temporal niche differentiation and productivity increase in intercrops (Yang Yu, Wageningen University)
09:30	Short Break			
09:40	Contrasting changes in the abundance and diversity of North American birds (Aafke Schipper, Radboud University Nijmegen)	The combination of plant characteristics and light availability shape the arbuscular-mycorrhizal community composition in plant roots (Kadri Koorem, University of Tartu / Netherlands Institute of Ecology)	An experimental test of the effects of hypoxia induced by floating vegetation on drainage ditch invertebrates (Ralf Verdonschot, ALTERRA - Wageningen UR)	Yield, growth dynamics and plastic outcomes of competitive interactions in wheat-maize intercropping in the Netherlands (Fang Gou, Wageningen University)
10:00	Individual stochasticity and variance in lifetime reproductive output in birds (Silke van Daalen, University of Amsterdam)	Mycorrhizal divergence and patchy distri-butions of mycorrhizal fungi in the soil contribute to coexistence of orchid species (Michael Waud, KU Leuven)	The role of mallards in the dispersal of plant seeds (Erik Kleyheeg, Utrecht University)	Quantifying pollination services by wild insects for Dutch fruit crops (Arjen de Groot, ALTERRA - Wageningen UR)

10:20	Population responses to environmental variation (Callum Lawson, Netherlands Institute of Ecology / Australian National University)	From the origins of plant-fungal symbiosis to the future of mycorrhizas in Europe's forests (Martin Bidartondo, Imperial College London)	The dark side of keystone mutualism: Mutualism breakdown triggers runaway landscape-scale degradation of seagrass beds (Jim de Fouw, Royal Netherlands Institute for Sea Research)	Seeking preconditions for system shifts in agricultural social-ecological systems (Carla Grashof, ALTERRA - Wageningen UR)
10:40	**Coffee and tea in the lounge**			
	Europe Hall			
	Plenary 2: "Biodiversity in Time and Space"			
11:00	1. **The evolution of Amazonian biodiversity** (**Alexandre Antonelli**, University of Gothenburg, Sweden)			
11.45	2. **Hyperdominance and hyperdiversity – the structure of Amazonian diversity** (**Hans ter Steege**, Naturalis Biodiversity Center, Leiden)			
12:30	**Lunch in the restaurant**			
13:30	**Poster Session 2 (Even-numbered posters are presented and discussed)**			
	Europe Hall	**America Hall**	**Asia Hall**	**Africa Hall**
15:00	**Parallel 4a: Biodiversity in Time and Space**	**Parallel 4b: The Dynamics of Ecotones**	**Parallel 4c: Ecology and Phytochemistry**	**Parallel 4d: Ecology in Practice**
	Conveners: 1. Daniel Kissling (University of Amsterdam) 2. Niels Raes (Naturalis Biodiversity Center)	*Conveners*: 1. Imma Oliveras (Wageningen University) 2. Maarten Eppinga (Utrecht University) 3. Matty Berg (Vrije Universiteit Amsterdam)	*Conveners*: 1. Kirsten Leiss (Leiden University) 2. Colette Broekgaarden (Utrecht University)	*Conveners*: 1. Wolf Mooij (Netherlands Institute of Ecology) 2. Margje Voeten (HAS University of Applied Sciences)
15:00	Integrative macroecology: towards understanding the history of biodiversity (Daniel Kissling, University of Amsterdam)	The Dynamics of Ecotones: An overview (Han Olff, University of Groningen)	An eco-metabolomic approach to study plant defence (Kirsten Leiss, Leiden University)	Nuisance macrophyte species: An unavoidable phase in restoration? (Michiel Verhofstad, Netherlands Institute of Ecology)
15:20	Differences in species richness patterns based on widespread vs. narrow-ranged species: the botanical diversity of Gabon (André van Proosdij, Naturalis Biodiversity Center / Wageningen University)	Who needs fire?! (Jon Loyd, Imperial College London)	Testing the generalist-specialist dilemma: the role of pyrrolizidine alkaloids in resistance to invertebrate herbivores in *Jacobaea* species (Xianqin Wei, Leiden University)	Counteracting land subsidence by sod-cutting; combined effects of restoration measures on C-fluxes and *Sphagnum* re-growth in former agricultural peatlands (Sarah Harpenslager, Radboud University Nijmegen)
15:40	Local scale soil biodiversity patterns in New York City's Central Park are comparable to those observed globally (Kelly Ramirez, Netherlands Institute of Ecology)	Shrub decline instead of shrub expansion in Arctic lowland tundra? (Monique Heijmans, Wageningen University)	Plant-soil feedback effects on plant chemistry and performance of aboveground herbivores (Martine Kos, Netherlands Institute of Ecology)	The challenge of mussel bed restoration (Hélène de Paoli, Royal Netherlands Institute for Sea Research)
16:00	Break			

	Parallel Session 4 Continued			
16:10	Global long-term ecological trajectories, dynamics and reorganizations (William Gosling, University of Amsterdam)	Savannas at the transition between forests and grasslands: modelling ecological processes at the continental scale (Mara Baudena, Utrecht University)	Plant-mediated interactions between multiple herbivores affect a subsequently arriving herbivore in populations of wild cabbage (Jeltje Stam, Wageningen University)	The Atlas Natural Capital: Pathways to a more natural and sustainable use of our environment (Ton de Nijs, National Institute for Public Health and the Environment)
16:30	Historical distribution of Sundaland's Dipterocarp rainforests at Quaternary glacial maxima (Niels Raes, Naturalis Biodiversity Center)	Shrub- tree interactions in boreal and subarctic ecosystems: paving the way for forest advance? (Milena Holmgren, Wageningen University)	Defense suppression benefits herbivores that have a monopoly on their feeding site but can backfire within natural communities (Joris Glas, University of Amsterdam)	Woody debris increases and stabilizes macrofauna abundances in river construction works (Ellen Weerman, HAS University of Applied Sciences)
16:50	Deep-time (0.1-10 My) dynamics of oceanic islands affect species richness (Kenneth Rijsdijk, University of Amsterdam)	Consumer-driven nutrient cycling determines plant nutrient limitations in African savannas (Michiel Veldhuis, University of Groningen)	Plant primary metabolites assembling as natural deep eutectic solvents and their possible role in drought- and freeze-tolerance (Eveline Rozema, Leiden University)	Long-range connectivity of coastal ecosystems through wave-dissipation depends on tidal range (Jim van Belzen, Royal Netherlands Institute for Sea Research)
	Europe Hall			

17:20	• **Awards ceremony**
	  ○ NERN Best Paper Award (Member of the NERN Evaluation Committee)
	  ○ NecoV Poster Prize (Maurice Hoffmann)
	• **Final words** (Louise Vet)			

	Lounge			
18:00	**Farewell drinks**			
18:30	**Dinner and NERN board meeting**			
19:30	**End / Travel Home** (Shuttle available between Conference Centre and Lunteren Station)			

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Presentation Abstracts

Plenary Session 1

Radical Ideas and Innovative Tools in Ecology

Often perspectives borrowed from other fields of research can offer insights for generating new hypotheses and approaches. While interdisciplinary research is touted as a goal in the ecological sciences, how often do we venture into radically different fields, such as physics or economics, to challenge ideas or gain insights? In this session, we explore novel tools and perspectives for brave ecologists. We argue that the frontier for studying ecological dynamics resides at the boundary between strikingly different disciplines.

1. **Zooming in to see the bigger picture: microfluidic and nanofabrication tools to study bacteria**
   (Felix Hol, Delft University of Technology)

The spatial structure of natural habitats strongly impacts bacterial life, ranging from (sub)micron structural features that individual cells exploit for surface attachment, to micro– and millimeter-scale chemical gradients that drive population-level processes. Nanofabrication and microfluidics are ideally suited to manipulate the environment at those scales, and have emerged as powerful tools to study the ecology of bacteria in the laboratory. In this talk I will discuss three microfabrication-based experiments in which we explore different ecological factors that shape bacterial communities. I will describe how we combine microfabrication, microscopy, and bacterial genetics to better understand bacterial competition in two model systems. By studying antibiotic-mediated competition in E. coli we demonstrate how regulatory mechanisms at the molecular level give rise to biodiversity patterns at the community-level. In a second experiment we explore how habitat fragmentation at the microscale influences bacterial predator-prey interactions. Thirdly, I will discuss how we use microfluidics to investigate bacterial population dynamics in landscapes of antibiotic gradients. Through these three examples I will demonstrate how the integration of innovations and techniques from various fields can help us to answer open questions in (bacterial) ecology.

2. **Visualizing symbiotic trade**
   (Toby Kiers, Vrije Universiteit Amsterdam)

Why is cooperation so widespread in nature? Biological Market Theory has emerged as a tool to study strategic investment of cooperating individuals; interactions can be analysed in terms of exchange between trading partners in a common market place. While historically the theory has been used to study animal interactions, microbes and plants also engage in complex social interactions and behaviours. For example, some root microbes provide higher quality services and resources than others. Host plants may discriminate and respond to this variation. However, while there is some evidence that non-cognitive organisms can negotiate conditions of trade, we do not know how partner performance is evaluated, nor how trade strategies respond to changes in resource levels, such as those predicted under global change models. A major open question is how we can visualize and quantify symbiotic trade over time. The evolution of “Microbial Markets” will be discussed, as well as how these markets may respond to climate change.

Plenary Session 2

Biodiversity in Time and Space

The biodiversity we see today is the result of processes generating and maintaining it, each at their own time and geographic scale. One of the world's largest stores of biodiversity – and carbon – is Amazonia. The sheer size of Amazonia has restricted the study of its biota. Recently, the compilation of huge datasets of ecological plots made it possible to unravel diversity, carbon storage, and forest functioning, while geological and vast molecular data are now making it possible to connect the present with the past. We will focus on the diversity and functional traits of trees in Amazonia as an example to connect actuo- with palaeo-ecology and address some of the problems faced, when working in largely unexplored areas.

1. The evolution of Amazonian biodiversity

(Alexandre Antonelli, University of Gothenburg)

Much is speculated concerning the timing and drivers of Amazonian biodiversity, but our knowledge is still based on a highly limited and biased number of case studies on charismatic organisms. Biodiversity, and the current distribution patterns observed today, are the result of three main biogeographical processes: speciation, extinction and range evolution. In this talk I will present novel integrative ways of using genetic, paleontological, geological and occurrence data to trace back the origin of Amazonia's living biota, as well as inferring the dynamics of diversification through time and space. I will end by arguing that the biggest challenge faced today is neither the lack of data nor methods: it is the current inability of the research community and funding agencies to work together towards resolving the most burning questions in biology and evolution, such as assembling the complete tree of life and digitizing the world's natural history collections.

2. Hyperdominance and hyperdiversity – the structure of Amazonian diversity

(Hans ter Steege, Naturalis Biodiversity Center)

With over 6 million km^2, the Amazon is one of the largest natural ecosystems in our world. The area hosts vast diversity and is also a large carbon store. Recent work showed that while 16,000 species of trees may inhabit the area, just 227 (1.4%) of them contribute 50% of all individuals. Over 11,000 (62%) species have populations less than 1 million individuals and make up less than 0.12% of all individuals of the Amazon. The fact that the area is dominated by so few may simplify the research into its functioning, focusing on the hyperdominants but the extreme rarity of so many species makes the study of diversity a challenge. How is this diversity distributed in space and among the angiosperm phylogeny and is there a link with its functioning? Can we predict how the Amazon will be affected by global change?

Parallel Session 1

1a: Radical Ideas and Innovative Tools in Ecology

Conveners: Felix Hol (Delft University of Technology)
Toby Kiers (Vrije Universiteit Amsterdam)

1. eEcology, the solution to data intensive ecology

Willem Bouten, Judy Shamoun-Baranes, Edwin Baaij, Wilco Hazeleger, Coen Schrijvers
University of Amsterdam / eScience Center / SURFsara

Global markets, economic drive, concerns about human health and security have resulted in technological innovations that influence our daily lives in many ways. The challenge is to continue to make use of new technological innovations in our ecological research as we already do with next-generation sequencing, physiological sensors, GPS tracking, wireless networks, ever more detailed remote sensing, and internet based citizen science and data exchange, all of which contribute to the Big Data explosion. To keep up with and take advantage of these new opportunities, we need the right infrastructure to support our research. Based on experience with our bird movement ecology studies we will share our answers to this changing world. We will explain how and why we selected ideas from eScience to develop eEcology. We will show how our "Virtual Laboratory" can be used by a large community of researchers to do remote fieldwork, to reduce the work load related to data management, to present data in a way that it provides insightful overviews, to merge, explore and analyse heterogeneous data to answer ecological questions, and to visualize data in a way that it generates inspiration to think of new questions. Our VL enables us to perform Big data analytics and to confront theoretical models with real data. The development and long term sustainability of such infrastructures is a challenge, which by definition should be carried out by interdisciplinary collaboration with strong involvement of or preferably led by ecologists.

2. Science on the intersection of art and hacking

Pieter van Boheemen
Waag Society

Waag Society's Open Wetlab is a laboratory that provides a platform for creative biotechnology. Our aim is to involve creatives, industry and academics hands-on in the shaping of biotechnology and what biotechnology shapes. In this talk we will explore several ways in which these exciting intersections take place and what this leads to. Our lab promotes the production of bio-art because we believe that bio-art is visionary and can be guiding for new prototypes and applications. For example in the project "Trust me I'm an Artist", we investigate to what extent and how art and science can work together and in what way art can influence a scientific agenda. And as co-initiator of the “Bio Art & Design Award” we support artists and scientists to bring those types of ideas to life.

3. Quantum physics, ecology and evolution of bacterial nanowires

Carsten Blom, Nandini Muthusubramanian, Herre van der Zant & Hubertus Beaumont
Delft University of Technology

All organisms require a resource that acts as an acceptor of electrons released by their metabolism. Although many organisms use oxygen for this purpose, bacteria can also use other molecules. The soil bacterium Geobacter sulfureducens has evolved a particularly interesting strategy to exploit an electron acceptor that is not readily accessible to its competitors. It uses protein nanowires to transfer electrons over large distances to extra-cellular iron-oxide particles. Wires from individual cells connect, forming an electrical grid that connects distant cells to iron-oxide particles. At present, very little is known about these wires and the networks they form—from the quantum physics of charge transport and cellular physiology to the population ecology and evolutionary forces that shape them. The following question outline the hiatus in our knowledge: How is it possible that proteins conduct such currents? What type of ecological interactions do nanowire connections enable? How does multi-level selection shape the properties of the nanowire network? I will present preliminary results from a project that seeks to address these questions on the basis of a multidisciplinary, hierarchical strategy that combines quantum physics with bionanoscience, microbiology and experimental ecology & evolution.

4. Muggenradar: Sourcing the crowd for mosquito surveillance

Chantal Vogels, Lennart van de Peppel, Arnold van Vliet, Linda Klein, Ron van Lammeren, Sander Koenraadt
Wageningen University

Traditional mosquito surveillance studies involve the use of traps to gain insight in the species that can be found in a specific area. We developed a novel crowd sourcing approach involving Dutch citizens, in order to gain insight in the occurrence and biting nuisance of the Northern house mosquito (*Culex pipiens* complex) in the Netherlands: Muggenradar. This unique approach allowed us to gain insight in the ecology of *Culex pipiens* inside houses, during both summer and winter. Citizens were asked to fill out an online questionnaire regarding mosquito nuisance and to send a dead mosquito specimen to our

laboratory during wintertime (Jan-Feb, 2014) and summertime (Aug-Sep, 2014). All mosquitoes (Diptera: Culicidae) were separated from other insects and identified up to the genus level based on morphology. A selection of *Culex pipiens* mosquitoes was identified up to the biotype level using real-time PCR. The approach was highly successful in involving Dutch citizens via regular and social media. Over 3,300 insects were submitted to our laboratory, including more than 2,000 mosquitoes. We will discuss the value and reliability of crowd-sourced data, as well as results on spatial and temporal patterns in the reports. This novel approach revealed interesting findings about biting nuisance that cannot be found with traditional surveillance studies. Our findings may have implications for risk assessments of disease transmission because *Culex pipiens* is considered as the most important vector for West Nile virus.

5. Quantitative imaging techniques to study carbon and nutrient flows

Matthew Whiteside
Vrije Universiteit Amsterdam

The mechanisms that control carbon and nutrient cycling between soils and plants remain central themes in ecosystem ecology. However, these processes have traditionally been quite difficult to track under natural conditions. For example, isotopic labels limit the total number of substrates that can be tracked simultaneously, and only the radioactive forms of an isotope can be observed visually. Our work focuses on the use of highly fluorescent nanoparticles, called quantum dots (QDs), to both visually and quantitatively track carbon (C), nitrogen (N) and phosphorus (P) throughout an ecosystem. Because different colors of QDs can be attached to a variety of different substrates, these resource exchanges can all be observed simultaneously. Using this novel technique, we are able to visually see what is going on in belowground ecosystems, highlighting soil processes that would otherwise be opaque. We have observed quantum dot-labeled C, N and P within bacteria, soil hyphae, and plant roots and shoots. Using quantitative imaging techniques, these resource exchanges can be visualized in both field and laboratory settings. This seminar will explore the use of quantum dot conjugates to address relevant ecological based questions.

6. Reproducible analytical workflows as efficient collaborative tools in microbial ecology

Leo Lahti
University of Helsinki / Wageningen University

Over a decade ago, the human genome sequencing project paved the way towards standard scientific data sharing practices. The subsequent standardization of data formats and the rapid expansion of open source approaches escalated into a global open science movement and the
development of collaborative tools that helped to make better use of scarce research resources, thus accelerating the development of the field. Recently, these approaches have gained popularity in research fields ranging from methodological to natural sciences to humanities. In the context of ecological studies, we maintain an open source project for microbial ecosystem analytics via the collaborative Github version control system at microbiome.github.com. The project provides constantly updated and transparent algorithms to process microbial community profiling data, to detect alternative stable states and early warning signals, and to carry out a number of other modelling tasks relevant for ecological studies and beyond. These tools consist of well-organized source code libraries supported by detailed on-line examples based on reproducible document generation tools such as iPython and Rmarkdown. The automated workflows ensure that the documentation stays up-to-date and is easy to use by other researchers, students, and citizen scientists. The open approach has allowed us to construct fully automated and transparent workflows spanning from raw data to pre-processing, statistical analytics and final publication-quality figures. I will discuss our experiences in utilizing these tools in international collaborations and provide guidelines for their successful application in ecological studies.

1b: Trait-based Approaches in Ecology

Conveners: Dedmer B. van de Waal (Netherlands Institute of Ecology)
Marjolein Sterk (Wageningen University)
Maayke Stomp (University of Amsterdam)

1. Understanding vegetation responses to environmental pressures using traits-based approaches

Peter van Bodegom
Leiden University

One of the primary aims of ecosystem models is to better understand spatial and temporal variation in vegetation responses to environmental pressures. Historically, both approaches tend to characterize vegetation by a limited number of plant functional types (PFTs), assuming that each of these PFTs represents a strategy and that the variation in traits within each of the PFTs is less than between PFTs. Recent trait compilations, however, have shown a large trait variation also within PFTs. In our work, we aim to apply traits-based concepts e.g. from assembly theory to ecosystem models, to better represent and evaluate the variation in traits expression. Indeed, when accounting for trait variation within PFTs through empirical trait-environment relationships, substantial changes in vegetation functioning and vegetation distribution compared to default model settings occur. Likewise, when applying similar concepts, spatial variation in Light use efficiency (a critical driver of e.g. MODIS products) is captured better. These principles can also be applied to understand species distributions and changes therein upon environmental change. This shows a need for better quantification and understanding (phenotypic) variation in trait expression as well as in trait-trait relationships (within species, within PFTs and between PFTs) in relation to commonly and less commonly measured traits. Together, our results show how traits-based approached can aid to better quantify vegetation functioning, now and in a future climate.

2. Interactive effects of bottom trawling and natural disturbance on benthic invertebrate community composition in soft-sediment habitats

Daniel van Denderen, Stefan Bolam, Jan Hiddink, Simon Jennings, Andrew Kenny, Adriaan Rijnsdorp, Tobias van Kooten
IMARES / Wageningen University

The need to understand how multiple disturbances affect natural systems has become increasingly important due to growing human pressure on ecosystems. Multiple disturbances interact and this implies that the influence of a single type of disturbance may not always show a clear relationship with the response of the community. Such interactive effects have long been suggested between the impact of bottom trawl fisheries and bottom shear stress on community composition in marine soft-sediment habitats. In this study, we examined the effects of these multiple disturbances on benthic community composition in 8 areas in both North Sea and Irish Sea using a biological trait-based approach. The traits were chosen to characterize community composition, describe ecosystem function and identify life-history strategies that are sensitive to disturbance. Our results indicate that both disturbances affect communities in similar ways and strongly change community structure and functioning by declining long-living, hard-bodied, suspension-feeding organisms. Effect of trawling on communities exposed to high natural disturbance is not observed. Other areas (but not all) show clear shifts in community composition in response to trawling and change benthic communities, relatively similar at low trawl intensity, into multiple compositions; communities dominated by mobile scavengers and predators or small-sized, short-living deposit feeders. Both shifts make communities more similar to a naturally perturbed situation. Our findings highlight the use of a trait-based approach to predict effects of future (trawl) disturbances on benthic communities and to assist management in finding a balance between exploitation of target species and conservation of marine soft-bottom habitats.

3. Bark trait dissimilarity determines soil fauna community composition

Juan Zuo, Matty Berg, Roy Klein, Jasper Nusselder, Gert Neurink, Mariet Hefting, Ute Sass-Klaassen, Richard van Logtestijn, Leo Goudzwaard, Jurgen van Hal, Johannes Cornelissen
Vrije Universiteit Amsterdam

Dead wood has significant ecosystem functions related to biodiversity and biogeochemical cycles. Dead wood on soil is colonised by an array of soil fauna, but what determines their species composition is not clear. During early decomposition, bark is an important component of wood, and is of critical importance for the assembly of fauna as it serves as an environment filter. We investigated the effects of bark traits, during early decomposition of wood, on invertebrate community structure of 11 common, temperature tree species in the LOGLIFE 'common garden' experiment. Bark traits studied were bark looseness, fissure index, rhytidome thickness, ratio of phloem to rhytidome and puncturability. Fauna groups studied were Annelida, Chilopoda, Coleoptera, Diplopoda, Diptera and Isopoda. We hypothesized that the more dissimilar bark traits were between tree species, the more the fauna community composition would differ. Our results showed (1) strong interspecific differences in bark traits, (2) bark traits related to environmental buffering have a profound effect on the abundance of several invertebrate groups, and (3) the higher the bark trait dissimilarity of tree species, the more

dissimilar these tree species are in fauna community composition. A suite of bark traits have fundamental effects on invertebrate community assembly, and act as strong environmental filters for early decomposition wood. These results indicate that forest stands with low tree species diversity but with trees that are more dissimilar in bark traits might harbor a higher soil fauna diversity than tree-species rich forests with species that are more similar in bark traits.

4. Competition for light and nutrients in layered communities of aquatic plants

Luuk van Gerven, Jeroen de Klein, Daan Gerla, Bob Kooi, Jan Kuiper, Wolf Mooij
Netherlands Institute of Ecology / Wageningen University

Dominance of free-floating plants poses a threat to the biodiversity in many freshwater ecosystems. Underneath these plants, the water often becomes too dark for submerged plants to photosynthesize and too low in dissolved oxygen for macrofauna and fish to survive. It is therefore crucial to know what drives the occurrence of floating-plant dominance and if this dominance can be a self-enhancing (alternative) stable state. Here, we propose a theoretical framework to understand this dominance, by modelling the competition for light and nutrients in a layered community of floating and submerged plants. The model shows that at high supply of light and nutrients, floating plants always dominate due to their primacy for light, even when submerged plants have lower minimal resource requirements. The model also shows that floating-plant dominance cannot be an alternative stable state in light-limited environments but only in nutrient-limited environments, depending on the plants' resource consumption traits. Compared to unlayered communities, the asymmetry in competition for light – while maintaining symmetry in competition for nutrients – leads to fundamentally different results: competition outcomes can no longer be predicted from species traits like minimal resource requirements (R^* rule) and resource consumption. Also, the same two species can, depending on the environment, coexist or show alternative stable states. When applied to two common plant species in temperate regions, both the model and field data suggest that floating-plant dominance is unlikely to be an alternative stable state.

5. From plant phenolics to functions: The role of phylogeny and trade-offs

Bart Grutters, Elisabeth Bakker
Netherlands Institute of Ecology

Functional plant traits and community composition both control ecosystem functioning. Community trait composition is not fixed however due to environmental change that continuously alters the optimal trait composition for species to live in a certain habitat. This turnover in traits will ultimately affect ecosystem functioning, but the question is how. To study this, our interest was drawn by the phenolic content of plants as it is omnipresent but can vary greatly between plant species. In addition, phenolics have major functions in plants, for example herbivory, nutrient cycling, allelopathy, disease tolerance and UV-B protection. Predictions on how trait shifts can be linked to alteration of functioning may be based on the analysis of current patterns therein. Therefore, we assess the relevance of phylogeny, life form and latitudinal origin in the understanding of how the phenolic content of aquatic plants links to functioning. Specifically, the relation between the total phenolic content of plants and their antibacterial capacity is explored. Moreover, the latter acts as a proxy for multiple plant functions like allelopathic strength, decomposition and disease tolerance. We show that phylogeny, growth form and latitudinal origin are crucial when unravelling how shifts in plant communities can affect functioning in a changing world.

6. Effects of seed traits on the potential of seed dispersal by fishes with a contrasting feeding strategy

Ger Boedeltje, Tom Spanings, Gert Flik, Bart Pollux, Ferdinand Sibbing, Wilco Verberk
Radboud University Nijmegen

For wetland plants, the important role of fishes in seed dispersal is increasingly recognized. To evaluate the role of both seed traits and fish traits in the potential of seeds for fish-mediated dispersal (ichthyochory), we fed seeds of 19 wetland plant species to fishes with a contrasting feeding strategy. *Cyprinus carpio* (common carp) has a pharyngeal 'mill', compensating for lack of both stomach and oral jaw teeth, while *Oreochromis mossambicus* (Mozambique tilapia) has many small pharyngeal teeth and an acid stomach. Multiple seed traits, including seed hardness, seed size and seed shape were important determinants of the potential of seeds for ichthyochory. Certain traits were more important during the ingestion phase (e.g. seed dimensions), whereas other traits were more important for seed survival and subsequent germination (e.g. seed hardness, mucilaginous coat). Moreover, the importance of seed traits was different among carp and tilapia, with some traits having interactive and contrasting effects in both fish species. Finally, carp increased in size during the experiment and concomitant decreases in seed survival and retrieval were found, suggesting that body size and the correlated bite force is an important fish trait in ichthyochory. Taken together, this study shows that hardness is crucial for seeds to survive gut passage in carp and tilapia, whereas a round shape is also important. However, underneath this general pattern a greater complexity of trait-performance relationships appeared: different seed traits are involved during each of the stages of ichthyochory and the importance and identity of traits varies between fish species.

1c: Spatial Ecology

Conveners: Koen Siteur (Utrecht University)
Maria J.F. Santos (Utrecht University)

1. Early life stages dictate the future: Plant species sorting along moisture gradients

Rob Fraaije, Cajo ter Braak, Betty Verduyn, Leonieke Breeman, Jos Verhoeven, Merel Soons
Utrecht University

Recruitment processes are critical components of a plant's life cycle. However, in comparison with later stages (e.g. competition among adults), little is known about the individual contributions of the three main recruitment processes—germination, seedling survival, and seedling growth—to community assembly, while quantitative information on these contributions is essential for a mechanistic understanding of plant species distribution and biodiversity. The natural hydrological gradients of riparian zones along streams provide a globally-relevant case study for evaluating the importance of the different stages of plant recruitment. To identify how recruitment contributes to vegetation patterns and biodiversity in riparian zones, we carried out field experiments at restored lowland streams. We quantified the germination of introduced seeds, and survival and growth of introduced seedlings of 17 riparian plant species across a gradient from the stream channel to upland. The hydrological gradient of riparian zones acted as a strong species-specific environmental filter, which initiated niche segregation along the riparian gradient during all three recruitment processes, particularly during germination and seedling growth. This suggests that at least some riparian plant species may have evolutionary adaptations that promote recruitment under favourable hydrological conditions for adult growth and reproduction. Our results suggest that strong environmental filtering during germination and seedling growth plays an important role in determining later adult distributions, by forming the spatial template on which all subsequent processes operate. In addition to well-known mechanisms, such as competitive exclusion at the adult stage, environmental filtering during early recruitment stages already strongly affect plant distribution and diversity.

2. Alternative stable states in a spatial Context – a case Study of Lake Taihu

Annette Janssen, Wolf Mooij
Netherlands Institute of Ecology / Wageningen University

China's third largest freshwater lake (2338km^2) Taihu is situated in the Yangtze River delta, approximately 100km west of Shanghai. The lake is very shallow with an average depth of only 1.9m. In the past the lake has been praised for its beauty, however since the 1980s, large parts of the lake turned into an algal soup as a result of excessive nutrient loads. Despite the deterioration by the blooming algae, other parts of the lake are still macrophyte rich. The spatial shift also appears higher up in the food web for example in the macro invertebrates. A modelling approach is used to examine the effects of lake size, heterogeneity and internal connectivity on the lake's response to eutrophication. With this approach we aim to get more insight in the presence of different stable states in Lake Taihu.

3. Added biogenic structure enhances landscape retention in a context-dependent way

Sil Nieuwhof, Jim van Belzen, Bas Oteman, Johan van de Koppel, Peter Herman, Daphne van der Wal
Royal Netherlands Institute for Sea Research

Ecosystem engineering species can add structure to their environment. Such structural change can have important consequences for the retention capacity of landscapes. Retention is important in maintaining valuable resources in the system, such as water or nutrients. On intertidal mudflats water retention results in tidal pools, which are important for biodiversity. While the importance of retention is clear, the effect of added structure by ecosystem engineers as opposed to landscape structure itself on retention remains poorly understood. Using artificial landscapes, we show that added structure can greatly enhance landscape retention. However, the added retention volume depends on the underlying landscape configuration. Our results show that at low densities, patchy aggregations of ecosystem engineers enhance retention and this effect is largest on relatively flat landscapes. Measurements confirm that the potential for retention is greater on mudflats with structure adding shellfish compared to bare mudflats at local reef- as well as estuarine scale. Our results provide valuable new insights into the importance and context dependence of added heterogeneous biogenic structure to landscapes.

4. Zooming in: spatial and temporal complexity in plant-soil feedback

Jasper Wubs, Martijn Bezemer
Netherlands Institute of Ecology / Wageningen University

Plant-soil feedback (PSF) studies have become a central component of our understanding of many terrestrial plant community processes, such as succession, invasion, local coexistence and diversity, and the biodiversity-productivity relationship. Much of this understanding is based on the preliminary assumption that local PSFs are independent of the feedback at neighbouring patches and the direct and indirect feedback build-up during previous seasons – in mathematical models responses are modelled only locally and without timelags. However, since PSFs are generated by the changes in abundance and interactions of soil biota in response to plants and soil biota can disperse and stay

dormant in the soil, this assumption needs to be tested. We present data from two simple experiments demonstrating that both feedback of neighbour patches and the sequence of previous occupants of a patch affects the local PSF at present. First, we varied the spatial heterogeneity in PSF, and found that plant performance cannot be predicted simply from the PSF in homogeneous soils. In the second experiment we found that the sequence of plant species conditioning the soil affects the current PSF. While it is premature to generalize based on these experiments, they do suggest that PSFs interact in complex ways in space and time. Quantification of the spatial and temporal dynamics of PSF is not only important for our fundamental understanding of plant communities, but also has important potential applications in nature restoration (e.g. legacy effects, nurse plants, soil transplantations) and agro-ecology (e.g. intercropping). Consequently they deserve more empirical and theoretical investigation.

5. Catching the wind: How experienced Honey Buzzards *Pernis apivorus* cope with sidewinds to complete long-distance soaring migration

Wouter Vansteelant, Judy Shamoun-Baranes, Willem Bouten
University of Amsterdam

In order to arrive at fixed individual breeding and wintering sites, migrating birds must compensate for wind drift, the displacement they accumulate from their shortest travel route due to the influence of sidewinds. Soaring migrants do not compensate for wind drift at all times along their migratory journeys. Instead, they adjust the extent to which they compensate for wind drift depending on the geographical region they are in, the season of migration, as well as the direction from which the wind is blowing. Part of this geographical and temporal flexibility in wind compensation strategies may be explained by a model of ´adaptive drift´: to drift at the onset of a journey, and to compensate close to the goal. Additionally, the potential of a bird to compensate for side winds depends on the airspeed at which it can glide between thermals, which is constrained by the rate at which it can climb in thermals. Yet it is unknown to what extent varying weather conditions determine geographical and temporal variability in wind compensation strategies of soaring migrants. We recorded more than 60 migratory journeys of adult European Honey Buzzards *Pernis apivorus* with GPS-loggers and analysed wind compensation behaviour at hourly intervals. Wind compensation behaviour was determined by local thermal soaring conditions, wind directions and wind speeds. Geographical and temporal variations in wind compensation behaviour can be related to local atmospheric support for soaring flight within a large-scale migration strategy of ´adaptive drift´. Our results help to explain, for example, seasonal loop migrations over the Western Sahara which have been observed in various species of long-distance migrants.

6. Spatial structure of an individual-based plant-pollinator network

Melanie Hagen-Kissling, Yoko Dupont, Kristian Trøjelsgaard, Marie Henriksen, Jens Olesen, Nanna Pedersen, Daniel Kissling
University of Amsterdam

Biodiversity is organised into complex networks of interacting species, which are increasingly analysed in the context of interaction networks. Local habitat structure and resource availability appear to be of great importance for the diversity, abundance, and community structure of such networks, but the effect of spatial structure on the composition (e.g. the modularity) of complex interaction networks remains largely unknown. Here, we link space and network ecology and investigate the spatial structure of an individual-based plant-pollinator network. We test how intra-specific variation in space use of individual flower-visitors (through small-scale movements and foraging behaviour) and the spatial structure of a plant population constrains structural properties of an ecological network. Using an animal-centred approach, we mapped the movements of tagged bumblebee (*Bombus* spp., Apidae) individuals and investigated their flower visitation behaviour within a spatial network of thistle stems (*Cirsium palustre*, Asteraceae). We found four modules/compartments of closely interacting bumblebee individuals and thistle stems, which were spatially separated within a local site. Statistical modelling revealed that thistle stems with high numbers of flower heads and many close neighbours were particularly important for connecting individuals within the modules, whereas tall plants and those near the patch centre were crucial for connecting the different modules to each other. Our individual-based and animal-centred approach shows how plant-pollinator networks are influenced by the fine-scale spatial structure of plant populations and highlights the need to incorporate foraging behaviour and intra-specific trait variation into analyses of plant-animal interactions across space.

1d: Trophic Interactions

Conveners: Liesbeth Bakker (Netherlands Institute of Ecology)
Maurice Hoffmann (Research Institute for Nature and Forest / Ghent University)
Chris Smit (University of Groningen)

1. Trophic interactions from a global change perspective

Liesbeth Bakker, Chris Smit, Maurice Hoffmann
Netherlands Institute of Ecology

Trophic interactions have strong consequences for the diversity and functioning of ecosystems. Most ecosystems are increasingly subject to global environmental changes, including eutrophication, changing land use and management practices, climate change, invasive species and many more. The question is how global change may alter trophic interactions and subsequently, how trophic interactions may mitigate or amplify global change impacts on aquatic, marine and terrestrial ecosystems. We use examples of our own work on plant-herbivore interactions and from literature to illustrate what is known and highlight which central questions are still largely unexplored.

2. Collapses of large piscivorous fish populations due to overfishing can be prevented and reversed by harvesting their prey

Floor Soudijn, André de Roos
University of Amsterdam

Several large piscivorous fish stocks have collapsed due to overfishing and show no full recovery after restrictions on fishing. The central Baltic Sea, where the cod population collapsed in the 80s, exemplifies such a regime shift. When prey fish are fished for in the same systems, it is commonly believed that this harms the large piscivores further or prevents their recovery ("fishing down the web"). In contrast, this study, focusing on Baltic cod, shows that harvesting its prey facilitates the recovery of cod from low densities. Harvesting prey releases intra-specific competition, increases population fecundity, and thereby changes the size-distribution of the prey population in such a way that cod benefits through an increase in its preferred prey items. Harvesting prey may furthermore help to protect the cod population against fishing-induced collapses and may even increase harvesting yields of cod. These consequences of prey harvesting result from the fundamental fact that somatic growth and reproduction are food- and hence density-dependent processes. In summary, fishing for prey fish can benefit large piscivorous fish, both before and after a population collapse.

3. Food web stability decreases prior to a critical transition in shallow lake ecosystems

Jan Kuiper, Cassandra van Altena, Peter de Ruiter, Wolf Mooij
Netherlands Institute of Ecology

Shallow lakes are often considered to be in one of two contrasting equilibrium states: a clear state with submerged macrophytes, or a turbid state dominated by phytoplankton. Between these two alternative states, rapid regime shifts may occur. Theory on alternative stable states explains such shifts from key components and feedbacks in the system, including non-trophic interactions, e.g. (interference) competition for light and nutrients between macrophytes and phytoplankton. Food web theory, on the other hand, focuses on trophic interactions to elucidate how the strengths and patterns of these interactions stabilize complex networks and regulate ecosystem state. We used concepts from both disciplines to study how specific patterns in trophic interactions, in terms of interaction strengths, relate to the resilience of the two alternative states. We combined a full-scale ecosystem model - PCLake - with a classical Lotka-Volterra type food-web model to show which interactions control food web stability during turbid and clear conditions, and that food web stability decreases gradually preceding a regime shift. Our results indicate that the structure of the food web, either expressed in terms of interaction strength patterning or the resulting food web stability, can serve as an 'early warning signal' of impending regime shift in lakes.

4. Interspecific plant interactions in response to the combined effects of drought and grazing pressure

Mart Verwijmeren, Chris Smit, Martin Wassen, Max Rietkerk
Utrecht University

Studies that explore the combined effects of drought and grazing on the direction and strength of plant-plant interactions are still very scarce. In this study, we performed an experiment in the semi-arid south-east of Spain in which we planted over 1200 saplings of the palatable shrub species Anthyllis cytisoides. Saplings were either planted sole standing or under the canopy of the unpalatable (protecting) shrub species Artemisia barrelieri. During a two year period, we measured growth and survival of saplings along four grazing treatments; ungrazed, low goat grazed, high goat grazed and rabbit grazed. Moreover, during the course of the experiment an extreme drought event occurred, which enabled us to study combined effects of extreme drought and grazing. Our results showed that in the absence of grazing the interaction between A. cytisoides and A. Barrelieri was neutral, prior to the extreme drought event. However, after the extreme drought, we found a higher survival of sole standing saplings, indicating a negative interaction. At goat or rabbit grazed sites we found increasing facilitative effects over time. However, after the extreme drought event, plant interactions shifted to

neutral, due to high overall mortality of saplings. Our results reaffirm that grazing can shift plant interactions from neutral to positive, but also show that positive interactions may wane under the combination of extreme drought stress and grazing. Pinpointing at what stress level positive interactions may wane along combined stress gradients, is crucial to predict how ecosystems will respond to future climate change or introduction of herbivores.

5. Parallel evolution in an invasive plant: How herbivore species affect competitive ability of *Jacobaea vulgaris*

Tiantian Lin, Peter Klinkhamer, Klaas Vrieling
Leiden University

A shift in the composition of the herbivore guild towards generalist herbivores in the invasive range is expected to select invasive plants with a higher competitive ability as they have to invest less in defence. We show here that parallel evolution took place in three geographically distinct invasive regions that differed significantly in climatic conditions. This makes it most likely that indeed the shifts in herbivore guilds were causal to the evolutionary changes rather than the adaptation to local abiotic factors after invasion. We studied competitive ability of invasive and native Jacobaea vulgaris using an intra-specific competition setup with herbivory by a specialist (*Tyria jacobaeae*), a generalist (*Mamestra brassicae*) and no-herbivore controls. We found that invasive genotypes have a higher competitive ability than native genotypes without herbivores. Since the invasive genotypes are more resistant to *Mamestra brassicae* and more susceptible to *Tyria jacobaeae* in the herbivore treatments, their competitive ability are significantly increased by *Mamestra brassicae* while it was reduced by *Tyria jacobaeae*. Furthermore, the studied traits of invasive genotypes from three geographically separated regions show consistent changes in magnitude and direction for all treatments, suggesting parallel evolution.

6. Gardening in the mud: Ragworms sprout cordgrass seeds for dinner

Zhenchang Zhu, Jim van Belzen, Tom Ysebaert, Peter Herman, Tjeerd Bouma
Royal Netherlands Institute for Sea Research

Cordgrass (*Spartina* spp.) is a common salt marsh pioneer plant, which is still extending its territory worldwide as invasive plague. Colonization by seeds plays a key role in the spread of *Spartina* in these introduced areas. Our study reveal that the feeding behaviour of ragworms (*Nereis diversicolor*), common on the mudflats across NW Europe, can have great influences on seed fate of *S. anglica.* Its feeding behavior is best described as gardening, as we found that these worms deliberately bury *S. anglica* seeds in or near their burrows, not eating the seeds until they have sprouted. This peculiar gardening behavior may lead unintended to an interesting pathway that allow occasional seedling establishment of *S. anglica.* Although sprout consumption is harmful for seedling production, seed burial by *N. diversicolor* is beneficial for seed persistence and seedling emergence. Since *N. diversicolor* is preyed upon by fish and shorebirds, this can lead to the occasional escape of *S. anglica* seedlings from herbivory. Our results suggest the potential that multi-trophic interactions may have for the reproductive success of this alien species on tidal flats.

Parallel Session 2

2a: Eco-evolutionary Possibilities and Constraints in Adjusting to Rapid Ecological Changes

Conveners: Christiaan Both (University of Groningen)
Philip Gienapp (Netherlands Institute of Ecology)

1. Eco-evolutionary possibilities and constraints in adjusting to rapid ecological changes

Christiaan Both, Phillip Gienapp
University OF Groningen / Netherlands Institute of Ecology

In this rapidly changing world populations should keep on adapting, or otherwise will decline towards extinction. Relatively little is known about the processes leading to adaptation, or what constrains the necessary adjustments. How long can species adjust by phenotypic flexibility and when is evolutionary change required, are important questions in this field that need to be answered if we want to predict ecological consequences of environmental change. Here we mainly apply these questions to existing long-time series on migration and breeding phenology of birds to climate change. These are among the few time series that are long enough to investigate the processes behind the observed changes. So far patterns are mostly explained by phenotypic plasticity, rather than evolutionary change. We also present new data on comparisons of multiple populations of a migratory bird to show that evolutionary changes can be observed locally, depending on the speed of warming.

2. A genetic matrix population model for eco-evolutionary dynamics

Hal Caswell
University of Amsterdam

There are four main conceptual frameworks for studying the interaction of ecological and evolutionary processes: classical population genetics, quantitative genetics, adaptive dynamics, and ad hoc optimization models. None of these are ideal. In this talk, I will present a newly developed framework that explicitly links simple Mendelian population genetics with matrix population models for demographic dynamics to create a truly eco-evolutionary model. There are no limitations on the kinds of ecological processes that can be included in the demographic component of the model: age- or stage-classified life histories of arbitrary complexity, linear or non-linear (density-dependent) dynamics, constant or time-varying (periodic or stochastic) environments. A complete sensitivity analysis of population growth and structure is available for the models. I will present examples of a case where allelic substitution creates an evolutionary rescue and a nonlinear case where evolutionary dynamics generate a bifurcation in population dynamics

3. In the tropics a long-distance migrant pays the bill for Arctic warming

Jan van Gils
Royal Netherlands Institute for Sea Research

Reductions in body size have recently been classified as a universal response to climate change. There is debate about whether these body shrinkages reflect adaptive or non-adaptive responses to higher temperatures. We show that an avian long-distance migrant (red knot *Calidris c. canutus*) that experiences globally unrivaled warming rates at its High-Arctic breeding grounds ('Arctic amplification') produces smaller offspring with shorter bills during summers with an early snowmelt. At their tropical wintering grounds, short-billed individuals have difficulties finding their deeply buried bivalve prey. In spite of having found an alternative food source in shallowly buried seagrass rhizomes, survival goes down with a decrease in bill size. This is the first study showing that a migrant pays a delayed price of rapid Arctic climate change while wintering in the tropics.

4. Adapt, move or perish: How range shift can cause maladaptation

Marleen Cobben
Netherlands Institute of Ecology

Species can respond to changing environment through phenotypic plasticity, evolutionary adaptation and tracking of suitable conditions. But how do these interact? Many species are locally adapted to decreased habitat quality at their range margins, and therefore show genetic differences across their ranges. We explored the effect of range shift on the level of adaptation throughout the species' range, using a simulation model of a woodland bird in fragmented habitat under increasing temperature. Generalist individuals had a large thermal tolerance but relatively low overall fitness, while climate specialists had high local fitness combined with a small thermal tolerance. Under stable temperatures, the populations in the range centre were comprised of the specialists, while the generalists dominated the margins. In contrast, as temperature increased, the number of generalists went up at the expanding margin, while the specialists became confined to the retracting margin. This led to overall maladaptation of the species and extinction of the specialist genotype, resulting in a reduced population size. We thus show that gene surfing under range shift can cause lower population sizes and loss of evolutionary potential, and therefore hamper the species' persistence under climate change.

5. **The role of dispersal and interspecific competition on local adaptation**
Adriana Alzate, Karen Bisschops, Rampal Etienne, Dries Bonte
Ghent University / University of Groningen

Besides selection, biological interactions and non-selective forces can influence the rate at which a species can adapt to a new habitat. However, experimental evidence is usually scarce. Here, using experimental evolution we investigate the role of dispersal and interspecific competition on the rate to which the spider mite (*Tetranychus urticae*) can adapt to a new host plant. Additionally, we test whether an increase in adaptation leads to an increase in competitive ability. Our results show a humpback shaped relation between dispersal and adaptation and a negative impact of competition on adaptation. We also show that populations that adapt to a new host without the presence of a competitor increase their competitive abilities when later exposed to competition.

6. **Rapid adaptation of herbivore consumers to nutrient limitation: eco-evolutionary feedbacks to population demography and resource control**
Steven Declerck, Andrea Malo, Sebastian Diehl, Dennis Waasdorp, Kimberley Lemmen, Konstantinos Proios, Spiros Papakostas
Netherlands Institute of Ecology

Humans alter biogeochemical cycles of essential elements such as phosphorus (P). Prediction of ecosystem consequences of altered elemental cycles requires integration of ecology, evolutionary biology and the framework of ecological stoichiometry. We studied micro-evolutionary responses of a herbivorous rotifer to P-limited food and the potential consequences for its population demography and for ecosystem properties. We subjected field-derived, replicate rotifer populations to P-deficient and P-replete algal food, and studied adaptation in common garden transplant experiments after 103 and 209 days of selection. When fed P-limited food, populations with a P-limitation selection history suffered 37% lower mortality, reached twice the steady state biomass, and reduced algae by 40% compared to populations with a P-replete selection history. Adaptation involved no change in rotifer elemental composition but reduced investment in sex. This study demonstrates potentially strong eco-evolutionary feedbacks from shifting elemental balances to ecosystem properties including grazing pressure and the ratio of grazer:producer biomass.

2b: Ecological Monitoring and Environmental DNA

Conveners: Michiel Hootsman (KWR Watercycle Research Institute)
Berry van der Hoorn (Naturalis Biodiversity Center)

1. Monitoring biodiversity using environmental DNA

Philip Francis Thomsen
University of Copenhagen

Ecosystems across the globe are under significant threat, suffering from various forms of anthropogenic disturbances, which are greatly impacting global biodiversity, economy and human health. Reliable monitoring of species is crucial for data-driven conservation actions in this context but remains a challenge owing to non-standardized and selective methods that depend on practical and taxonomic expertise, which is steadily declining. DNA obtained from degraded and environmental samples is continuously being used in biodiversity monitoring. Especially environmental DNA (eDNA) – DNA obtained directly from water, soil etc. – has proven a successful avenue in both ancient and contemporary environments, and may be an appropriate candidate for the conservation challenge, since it is cost-efficient, easy-to-standardize and non-invasive. The rapid advance in DNA sequencing technology has revolutionized the use of eDNA and opened new frontiers in ecology, evolution and environmental sciences. Coupled to DNA-metabarcoding (simultaneous identification of multiple DNA-sequences from a complex sample), it is now possible to study entire species assemblages in an ecosystem using a cup of water or a scoop of soil. In my talk, I will give an introduction to the achievements of eDNA, especially for monitoring macro-organisms in contemporary ecosystems as a mean for biodiversity assessment. I will focus mainly on aquatic systems – both freshwater and marine, and address challenges and perspectives of eDNA for biodiversity monitoring.

2. Low PH and presence of organic matter reduce the amount of detectable environmental DNA in freshwater

Kees van Bochove, Freek Bakker, Kevin Beentjes, Berry van der Hoorn, Jitske Rook, Rutger Vos, Barbara Gravendeel
Naturalis Biodiversity Center / Wageningen University

Environmental DNA is increasingly used for monitoring the occurrence of freshwater organisms. In different projects, Naturalis Biodiversity Center is involved in applicated eDNA projects in different substrates. Various studies show a relation between the amount of eDNA and population density. Environmental factors such as water temperature and microbial activity are known to affect the amount of eDNA as well. We carried out an aquarium experiment using *Gammarus pulex* L. (Amphipoda) to study the relationship between the amount of detectable eDNA and pH and organic material. DNA degraded faster in acid water especially when organic material was added to the aquariums. These results indicate that, although estimation of population density might be possible using eDNA, the relation between the observed Cq-value and population density needs be calibrated depending on the local environmental conditions.

3. Monitoring six fish species in a field study by environmental DNA detection using qPCR in comparison with trap catches

Bart Wullings, Wouter Patberg, Jan Warmink, Edwin Kardinaal
KWR Watercycle Research Institute

Periodically, water bodies are monitored for the presence of fish species to meet national and international legal requirements. Traditional methods using traps, scoop net or electrofishing are expensive, incomplete and disruptive for the environment. Environmental DNA (eDNA) detection has emerged as a powerful tool for monitoring aquatic organisms. However, much remains unknown about the dynamics of aquatic eDNA in streams and rivers. To improve understanding of the dynamics of eDNA in comparison with traditional monitoring strategies a field study was conducted in the IJssel river in the Netherlands. In the autumn of 2014, six fish species were monitored by traditional trap catch and quantitative eDNA detection with qPCR. These species were selected based on historical monitoring data as being common (European perch, *Perca fluviatilis*, and Common roach, *Rutilus rutilus*), less common (Ide, *Leuciscus idus*, and Common bleak, *Alburnus alburnus*) and rare (Wels catfish, *Silurus glanis*, and Bullhead, *Cottus perifretum*). A sampling strategy was designed to enable a statistical comparison of both monitoring methods. On three locations, separated by approximately 1.5 km, traps were placed and fish species caught were counted three days in a row. At each of these locations on several distances from the river bank stratified water samples were taken also and analysed using newly developed multiplex qPCR methods. All six fish species were detected by eDNA in the water samples. The relation with the trap catches and implications for future monitoring efforts will be discussed.

4. Monitoring fish using environmental DNA barcoding & metabarcoding

Jelger Herder, Jan Kranenbarg, Alice Valentini
Reptile, Amphibian and Fish Conservation

The environmental DNA method is a relatively new approach used to monitor the distribution of (aquatic) species. The method uses DNA-based identification, also called barcoding, to detect species from extracellular DNA, or cell debris, that species leave behind in the environment. So far much research has focussed on a species specific approach, using species specific primers to detect the presence of a species (for example the Habitat directive species *Misgurnus fossilis* and *Triturus cristatus*). Another approach is eDNA metabarcoding in which universal primers are used that amplify DNA of a whole group of species (for example fish or amphibians). After amplification of DNA in the PCR, the product is sequenced with a 'Next Generation Sequencer' (NGS). The amplified sequences are matched to sequences in a reference database to generate a list of species present. We will briefly summarize some results of the species specific approach which show that the eDNA method performs better than traditional monitoring. Second we present results of our study in which eDNA metabarcoding was compared to traditional electrofishing following the Water Framework Directive protocols. In stagnant waters eDNA-metabarcoding performed better than traditional monitoring by detecting the same or a higher number of fish species. Furthermore we found indications that there is a relationship between the abundance of fish species and the amount of eDNA detected.

5. A new technique for detection of eDNA in water samples: a test on four aquatic species

Arjen de Groot, Ivo Laros, Jouke van der Zee, Ben Crombaghs
Alterra – Wageningen UR

Non-invasive genetic monitoring of wild animals is getting increasingly popular among researchers and managers, since it yields valuable insights in their distribution without disturbing vulnerable populations or ecosystems. The possibility to detect environmental DNA (eDNA) in water samples now allows us to apply such monitoring also on aquatic species. Yet, the optimization of techniques and exploration of both potential applications and limitations is still ongoing. To properly assist management decisions, it will be particularly important to improve the replicability and reproducibility of results, and to be able to draw conclusions about species abundance, rather than presence/absence only. A new detection technique based on digital droplet PCR (ddPCR) potentially offers more reliable detection of rare molecules and a more straightforward quantification of DNA concentrations, compared to the qPCR platform that has been used in most studies. In 2013 we conducted a number of small-scale studies in which we used eDNA-based detection to screen a collection of field samples for four different species by means of eDNA: Red swamp crayfish (*Procambarus clarkii*), Common spadefoot toad (*Pelobates fuscus*), Great crested newt (*Triturus cristatus*) and European weather loach (*Misgurnus fossilis*). We applied both qPCR and ddPCR on the same samples and compared their performance with respect to replicability, quantifiability and cost-effectiveness. Our results suggest that ddPCR does not yield much lower detection limits, but that results are more consistent among replicates. The higher cost-efficiency of ddPCR at large sample sizes will improve the applicability of eDNA-based methods in large-scale monitoring programmes.

6. Second generation sequencing and morphological faecal analysis reveal unexpected foraging behaviour of Myotis dasycneme (Chiroptera, Vespertilionidae)

Anne-Jifke Haarsma, Elza Duijm, Youri Lammers, Barbara Gravendeel
Naturalis Biodiversity Center / Radboud University Nijmegen

Many bat species depend on aquatic habitats for their major food supply. Of the European Vespertilionidae at least five species can be found foraging along water bodies. The pond bat (Myotis dasycneme, Boie 1825) is probably the largest and most adapted European water foraging bat, yet the least studied. The species is often observed trawling above the water surface, feeding mainly on Chironomids according to visual observations. Detailed dietary analysis can reveal if the observed foraging behavior is consistent with faecal contents. Using two methods, microscopic analyses of faeces and second generation sequencing, simultaneously, we were able to obtain new insights in the diet of the pond bat. We compared the results obtained from both methods and were able to demonstrate that metabarcoding is a valuable alternative for traditional microscopic analyses. However, both methods were found to have their advantages and disadvantages. Without a good understanding of these limitations, interpretation of the results can lead to under- or overrepresentation of certain insect groups. We discovered that the correct genus or species are not always found for insect groups that still lack sufficient sequence references. This can result in erroneous identifications, especially in Arthropod families and orders as these are particularly underrepresented in the sequence reference libraries currently available.

2c: Disease Ecology - part 1: Understanding spatio-temporal variation in disease dynamics

Conveners: Fred de Boer (Wageningen University)
Dieter Heylen (University of Antwerp)
Kevin Matson (University of Groningen)

1. A resource-based habitat approach for spatial modelling of vector-borne disease risks

Nienke Hartemink, Sophie Vanwambeke, Bethan Purse, Marius Gilbert, Hans Van Dyck
Utrecht University

Landscape factors, including land use, land cover composition and structure, are important drivers for vector-borne disease risk. There is a clear need to assess landscape suitability for the emergence and spread of these diseases. Since vector-borne pathogens rely on at least one vector and one host species, disease occurrence is linked to areas where habitats of these species overlap functionally. These areas do not necessarily coincide with specific vegetation types, which hampers the correct identification of areas at risk. Current modelling approaches neglect components of the functional habitat of vectors or hosts, and hence of the pathogen. Empirical-statistical methods do not explicitly incorporate biological mechanisms, whereas current mechanistic models are rarely spatially explicit; both methods ignore the way animals use the landscape (i.e. movement ecology). Applying a functional concept for habitat, i.e. the resource-based habitat concept (RBHC), can solve these issues. RBHC offers a framework to systematically identify ecological resources necessary for the completion of the transmission cycle and to relate these resources to (combinations of) landscape features. The potential of RBHC as a framework for identifying suitable habitats for vector-borne pathogens is illustrated with the case of bluetongue virus. The concept facilitates the study of functional habitats of the interacting species (vectors as well as hosts) and provides new insight into spatial and temporal variation in transmission opportunities and exposure that ultimately determine disease risks. It may help identifying knowledge gaps and control options arising from changes in the spatial configuration of key resources across the landscape.

2. Surviving infection, the insect egg is able to defend itself against bacteria

Chris Jacobs, Herman Spaink, Maurijn van der Zee
Leiden University

Insects are the most diverse group of animals on earth. They inhabit nearly all terrestrial habitats. One of the factors underlying this success is the ability of insect eggs to survive in adverse conditions. Not only larvae and adults but also insect eggs are constantly threatened by pathogens. For a long time the ability to survive infection has been attributed to maternal investment in the form of a protective eggshell, sometimes coated with antimicrobials. Contrary to common belief, insect eggs are far from helpless. The insect egg itself develops a cellular layer around the egg called the serosa. In the red flour beetle (*Tribolium castaneum*), it is possible to prevent the development of the serosa by knocking down the gene *zerknüllt* by RNA interference. Utilizing this method to compare eggs with and without a serosa, we found that this serosa protects the developing embryo from infection. Eggs with serosa mount an impressive immune response upon the entry of bacteria in the egg, whereby they induce all the same immune genes that are utilized in adult beetles. In eggs without serosa, bacteria grow twice as fast and these eggs are unable to induce immune genes. The data presented show the importance of the serosa in the survival of the insect egg. We propose that the serosa contributed to the great success of insects.

3. *Ixodes ricinus* and *Borrelia burgdorferi* s.l. populations are maintained by a few common host species

S. Ruyts[1], T. R. Hofmeester[2], E.C. Coipan, E. Ampoorter, S.E. van Wieren, H.H.T. Prins, W. Takken, K. Verheyen, H. Sprong
[1]Ghent University, [2]Wageningen University (combined talk)

In the northern hemisphere, ticks of the *Ixodes ricinus* complex are the most common vectors of diseases such as Lyme borreliosis and Tick-borne encephalitis. These ticks are generalists and have a three-host lifecycle for which the ticks are dependent on three different hosts for their blood meal. Finding out which host species contribute most in maintaining ticks and the pathogens they transmit is imperative in understanding the drivers behind the dynamics of the disease. By analysing data from a selection of 58 published studies on host interactions with the tick *Ixodes ricinus* and the pathogen *Borrelia burgdorferi* s.l., the causative agent of Lyme borreliosis, we show that only a few selected host species, small rodents, thrushes and deer, which are amongst the most common species in the environment, are contributing most to feeding *I. ricinus*, and infecting it with *B. burgdorferi* s.l.. We confirmed these results via a large scale study on the prevalence of infection in ticks in the Campine region in Belgium. We caught ticks in 20 forests and examined the prevalence of *Borrelia* genospecies in the ticks. Preliminary results show that the genospecies community composition, and subsequently also the host community composition, differs between different forest types. Overall, *B. afzelii*, the rodent associated genospecies, comprised 73% of the community. This implies that community composition influences disease risk, as different *Borrelia* genospecies have different clinical symptoms.

2c: Disease Ecology - part 2: host-parasite coevolution

Conveners: Ellen Decaestecker (KU Leuven)
Bregje Wertheim (University of Groningen)
Tine Huyse (KU Leuven / Royal Museum for Central Africa)

4. Elemental changes along a temporal and spatial gradient: Does it impact *Daphnia*-parasite interactions?

Lien Reyserhove, Jessie Engelen, Kristien Brans, Luc De Meester, Ellen Decaestecker
KU Leuven

Urbanisation and eutrophication have played a crucial role as drivers of local, regional and global changes in N and P biochemistry of aquatic ecosystems. Moreover, as the rate of N and P-inflow can differ considerably, we expect the aquatic N:P ratio to vary. As many aquatic grazers perform best under a fixed N:P ratio, this altered food quantity and quality can impact their life history traits directly (growth, mortality) or indirectly (predation, immune defences). Although often neglected, defences against parasites are important as they regulate host density or susceptibility to predation. Here, we focused on how a temporal and spatial gradient in nutrient availability impacted the interaction between *Daphnia* and its parasites. In a laboratory experiment, we used two *Daphnia* subpopulations that were hatched from different sediment layers in a pond from which we characterized the changes in nutrient household over time. Our results show that a higher nutrient availability in time induces a higher sensitivity of *Daphnia* with respect to changing N:P ratios, which in turn resulted in a higher parasite virulence for these sensitive clones. Secondly, we monitored changes in phytoplankton N- and P-concentration and ratio of 81 ponds in Flanders. Our results indicate that on a local scale (within 9 km^2), phytoplankton N-concentration and N:P ratio increased with the percentage of build-up area around the pond. This altered elemental context impacted the interaction of three different zooplankton species (*Daphnia magna, D. pulex and Simocephalus vetulus*) with their parasites.

5. Genetic variation in parasitoid resistance in natural populations of *Drosophila melanogaster*

Sylvia Gerritsma, Laura Salazar-Jaramillo, Kirsten Jalvingh, Carmen van de Beld, Jelmer Beerda, Ammerins de Haan, Bregje Wertheim
University of Groningen

Insect immunity is among the fastest evolving traits, due to the severe impact of parasites on fitness and survival of the hosts, and the dynamic co-evolutionary arms races among hosts and parasites. We focus on the interactions among *Drosophila* hosts and their parasitoids. Parasitoids are a major source of mortality for many insect species, because they lay their eggs in other insects, and the developing parasitoid larvae kill the hosts. Host-parasitoid interactions vary among geographical regions due to local variation in environmental factors and species interactions, creating variation in host immunity among local populations and species. In our study we use a comparative approach among natural *D. melanogaster* populations to study the genetic basis of their fast evolving immune response. Our objective is to associate genetic and genomic variation to the phenotypic variation for this trait. We collected *D. melanogaster* flies from populations across Europe and tested their resistance by measuring encapsulation ability and hemocyte load. We showed large geographic variation in resistance among natural populations of *D. melanogaster*, and could associate this to certain characteristics in hemocyte compositions. Although the variation in resistance within *D. melanogaster* was comparable to the variation found among *Drosophila* species, we showed that the mechanisms that applied to between-species variation did not apply for within-species variation. To identify the genetic basis underlying the variation in parasitoid resistance, we sequenced 12 candidate genes for parasitoid resistance, including five receptor genes, in the field lines to quantify polymorphisms and heterozygosity within and between the natural populations.

6. Host specificity in ticks

Raoul Van Oosten, Dieter Heylen, Erik Matthysen, Kurt Jordaens, Thierry Backeljau
University of Antwerp

Ticks are a numerous group of hematophagous ectoparasites, and under natural circumstances most species infest one or only very few hosts. It is, however, largely unknown whether this is due to host specialisation or simply because ticks do not come into contact with other hosts. Therefore we investigate population dynamics and host specificity in the endophilic tick *Ixodes arboricola*, whose life cycle is limited to tree holes and therefore infests only cavity-nesting birds such as great and blue tits. Our studies indicated that the life cycle of *I. arboricola* is strongly associated to that of its hosts (Heylen *et al*, 2014, Parasitology) and that therefore its populations are genetically differentiated even at small spatial scales (Van Oosten *et al*, 2014, Heredity). In two recent studies, we found no differences in feeding performance of this tick among several cavity-nesting birds but lower feeding performance on an unnatural host, while such differences were absent in the generalist tick *Ixodes ricinus*. This provides evidence that ticks are host-specialised and not just constrained by habitat (Van Oosten *et al*, 2014, Parasitol Res; Van Oosten *et al*, in prep).

2d: Carbon Cycling: the Importance of Microbes

Conveners: Annelein Meisner (Lund University)
Ciska Veen (Netherlands Institute of Ecology)

1. Linking microbial ecology to soil carbon cycling

Annemieke van der Wal
Netherlands Institute of Ecology

There is a societal and scientific need to better understand biological processes that influence ecosystem functions. Carbon cycling is a key ecosystem function in soils, and microbial communities are crucial in the breakdown of soil organic matter that can be reused by other organisms. Thus, activity of soil microbial communities and carbon cycling processes are tightly linked. Remarkably, the relation between microbial community composition and the process rate and fate of organic matter still remains underexplored. In this talk I will present recent insights into factors affecting microbial carbon cycling and introduce the speakers of this session who contributed to shed light on this timely topic.

2. Priming of soil organic matter and fungal ecology: Is there a link?

Paolo Di Lonardo, Wietse de Boer, Silja Emilia Hannula, Annemieke van der Wal
Netherlands Institute of Ecology

Priming effect (PE) is defined as a short-term change in the turnover of soil organic matter (SOM) caused by the addition of relatively easily degradable organic compounds to the soil. This process is recognized to be large enough to be taken into account into the ecosystem carbon balance. By following the dynamics of SOM decomposition as well as that of microbial structure and activities, information can be obtained on the causes of PE. It has been suggested that fungi might play a major role in PE since they are able to make a spatial connection between easily-available carbon and stable SOM via their hyphae. Yet, the exact mechanisms of PE are still unknown. In the current study we addressed the following questions: 1) What is the main mechanism controlling the PE? and 2) Which fungal taxa are mainly causing PE? To answer these questions, three isotope-labelled PE-triggering substrates, which differ in structure and degradability, were added to a natural grassland soil in a mesocosm approach. After four weeks of incubation we found significant differences between the treatments in the cumulative CO_2 release and in PE. The most recalcitrant compound gave the highest PE, and this might be explained by the activation of micro-organisms that synthetized specific extracellular enzymes able to decompose both the triggering substrate and the SOM. In general, nitrogen addition also influenced PE and results will be discussed. To answer the second question, we are currently running DNA-SIP analysis with which we will be able to track fungal taxa that are actively involved in PE.

3. Negative priming effects of root decomposition by plant presence

Sirgi Saar, Marina Semchenko, Janna Barel, Gerlinde De Deyn
Tartu University / Wageningen University

Litter decomposition is positively related to its nutrient concentration. However, the presence of living roots can affect decomposition rates by releasing root exudates which can give saprotrophic microbes an energy boost, enabling them to degrade litter faster. Such positive priming effects have been reported for soil organic matter and leaf litter. To test whether and how plant presence affects decomposition of roots with different traits we set-up a root decomposition experiment using dead roots of seven plant species (3 grasses, 3 legumes, 1 forb). Litter bags containing single species dead roots (0.5 g dw) were buried in pots with soil without plants or with a growing white clover plant (*Trifolium repens*). The litters were left to decompose in the greenhouse for eight weeks under controlled temperature and soil moisture levels after which their mass loss was determined. We expected that the root decomposition rate would increase in the presence of the living plant, especially for litter that decomposes slowly in absence of plants. In contrast to our hypothesis we found that the presence of the living plant decreased the decomposition rate of the roots of the grasses and forb, while the decomposition rate of legume roots was not significantly affected by plant presence. Our results show that the decomposition rate of roots can be slowed by the presence of a living plant but that this effect depends on the properties of the decomposing roots. Relatively nutrient-rich legume root litters are not affected in their decomposition rate by plant presence while root litter of species poor in N and P are retarded in their breakdown. As underlying mechanism we propose that the microbial communities behaved according to the Preferential Substrate Utilization hypothesis, which postulates that when the organic matter requires too much energy to be degraded, microorganisms switch to use easier to decompose organic matter such as root exudates as a C source.

4. Fungal role in carbon flow in the rhizosphere along a chronosequence of abandoned agricultural soils

Emilia Hannula, Elly Morriën, Wim van der Putten, Hans van Veen
Netherlands Institute of Ecology

Many of the ecosystem services provided by soils, such as plant growth, organic matter cycling, carbon sequestration and pathogen suppression occur through actions of microbes. Here, we present results on the structure of and the diversity within fungal communities active in soil along a chronosequence

of ex-arable fields in The Netherlands. These fields are typically managed by low-intensive grazing while undergoing a transition from an arable system into species-rich grassland. We hypothesized that the role of fungi in soil processes would increase with increased time after abandonment from agriculture and that this would have further consequences to soil functioning.
In order to assess the short term fate, turnover and retention of recent plant-assimilated carbon and study active soil communities in these systems, intact soil cores were collected and pulse labelled with $^{13}CO_2$. The fungal contribution to the processes was evaluated using PLFA-SIP and community structure and diversity was analysed using DNA-SIP combined with 454-sequencing. Upon labelling, most of the root derived ^{13}C was found in fungal biomass. Interestingly, fungi in the cores from long-term abandoned fields received significantly more carbon from the plants than the fungi in the short-term abandoned fields in which bacteria dominated. This further affected the carbon flow through the system. We also observed also a shift in fungal feeding community: fungal carbon in recently abandoned field was later detected in fungivorous nematodes while in fields longer out of production fungal carbon was mainly consumed by prostigmatic mites. This was related to a shift in functional groups of active, ^{13}C labelled fungi, in the rhizosphere. These results highlight the importance of fungi in the grassland rhizosphere and their role in the carbon cycling. We will discuss these results in relation to the soil biodiversity, carbon cycling and ecosystem function.

5. Quantifying differential impacts of arbuscular and ectomycorrhizae on ecosystem carbon budget

Nadia Soudzilovskaia, Marcel van der Heijden, Hans Cornelissen, Mikhail Makarov, Vladimir Onipchenko, M.N. Maslov, A.A. Akhmetzhanova, Peter van Bodegom
Vrije Universiteit Amsterdam

A significant fraction of soil carbon moves through arbuscular mycorrhizal (AM) and ectomycorrhizal (EM) associations. However, the impact of both AM and EM on the soil carbon budget and carbon transformations is still poorly understood. Current knowledge on differences in carbon cycling between AM and EM dominated ecosystems is mostly based on correlative studies where AM and EM dominated plant communities were compared. We propose a method to quantify the mycorrhizal contribution to carbon cycling explicitly accounting for plant-associated and extraradical mycorrhizal mycelium abundance. Using this method we provide, for the first time, a quantitative assessment of mycorrhizal impact on biomass carbon stocks in tundra ecosystems. We compared carbon allocation patterns in sub-arctic alpine tundra plots dominated by either by AM or by EM vegetation. We demonstrate that AM mostly affects ecosystem biomass carbon stocks via living plant biomass, while EM does so via extraradical mycelium of EM fungi, i.e. in our study system the AM-associated carbon stock in plant biomass was nearly equal to the amount of carbon stored in AM mycelium, while 70% of the EM-associated carbon pool is stored in EM mycelium. We also show how the magnitude of the ecosystem biomass carbon stock and the ratio of fungi-to-plant carbon allocation could change due to a realistic vegetation shift for this biome from AM to EM dominance due to encroachment of the ectomycorrhizal shrub *Betula nana* L. This issue is highly relevant and urgent, because expansion of shrubs (which are often ectomycorrhizal) is recognized as one of the major consequences of climate warming at high latitudes and altitudes. We discuss how the proposed method can be applied at various scales from ecosystem to global level, and present a new global database of plant species-by-site intensity of plant root colonization by mycorrhizal fungi. Our work paves the way towards improved understanding of the role of mycorrhiza in the Earth's carbon cycle.

6. Climate warming alters communities of soil ascomycetes in arctic Alaskan tundra

Tatiana Semenova, Luis Morgado, Jeffrey Welker, Marilyn Walker, Erik Smets, József Geml
Leiden University

The arctic tundra stores almost 50% of the Earth's carbon as frozen organic matter. However, in recent decades, this carbon is being released to the atmosphere as a greenhouse gas due to warming-induced alterations of key processes in arctic ecosystems. Rising temperatures have been leading to major shifts in arctic plant communities and their associated soil fungi with implications for decomposition rates and nutrient cycling. In this study we quantified the responses of the most diverse group of arctic fungi, the ascomycetes, to long-term (ca. 18 years) experimental summer and winter warming. Using deep Ion Torrent sequencing we analyzed these assemblages in dry and moist tundra of arctic Alaska, and estimated how the proportions of various ecological groups changed due to experimental warming. In the moist tundra, where plant communities shifted in response to warming, both summer and winter climate manipulations significantly altered taxonomic and ecological assemblages of soil ascomycetes. We found an increase in saprotrophic ascomycetes. This is in agreement with previous reports of warming-induced increases in decomposition rates, which could have implications for the carbon cycle in arctic tundra ecosystems. In dry tundra, where plant communities were less responsive to warming, winter and summer warmings had the opposite effect on ascomycete assemblages, suggesting competing responses that counter-act each other which in turn may minimize increases in ecosystem nutrient cycling

Parallel Session 3

3a: Avian Population Studies

Conveners: Eelke Jongejans (Radboud University Nijmegen)
Maja Roodbergen (Netherlands Institute of Ecology)

1. Avian population studies in the Netherlands

Maja Roodbergen, Eelke Jongejans
Netherlands Institute of Ecology

Birds are well loved and studied by both scientists and amateurs due to their ability to fly and their good detectability and near omnipresence. In the Netherlands, many people collect data on numbers, movements, survival and reproduction. Relating these data to environmental variables and combining them in population models allows us to better understand population dynamics, both of birds and other species. This understanding is instrumental to effective species conservation and management. I will give a general overview of avian population studies in the Netherlands, discuss different modelling approaches and give applied examples.

2. Spatial demography of black-tailed godwits in a mosaic of traditional and modern agricultural landscape

Rosemarie Kentie, Jos Hooijmeijer, Christiaan Both, Theunis Piersma
University of Groningen

The numbers of black-tailed godwits (*Limosa limosa limosa*), an iconic bird species breeding in the Netherlands, have declined with 75% over the last 50 years. The main reason for this decline is agricultural intensification: wet herb-rich meadows were transformed into modern grassland monocultures, which are mowed during the incubation phase. Despite many agri-environmental conservation schemes, the population is still declining. In this study we tried to decipher why godwits are in decline by investigating and understanding population changes using solid demographic analyses. We compared the fates of godwits breeding in our modern agricultural landscape, where industrialized grassland monocultures form the vast majority, and where the original herb-rich meadows are now mainly found in special conservation areas. We show that grassland monocultures act as a sink (where reproduction does not compensate mortality), and herb-rich meadows as a source (where more individuals are born than the annual loss). Moreover, we show that, although meadows were on average favoured over monocultures, the presence of monocultures prevent recovery of godwits on meadow habitat.

3. Effects of nocturnal illumination on wild bird communities

Maaike de Jong, Roy van Grunsven, Roy Slaterus, Elmar Veenendaal, Frank Berendse, Marcel Visser, Kamiel Spoelstra
Netherlands Institute of Ecology

The effects of artificial night lighting on animal behaviour, fitness and population dynamics are largely unknown. Most studies report short-term consequences in locations that are also exposed to other anthropogenic disturbance. Moreover, we know little about how the effects of nocturnal illumination vary with different light colour compositions. This is increasingly relevant as the use of LED lights becomes more common, and LED light colour composition can be easily adjusted. We will present a large scale, ecosystem-wide study where we experimentally illuminate forest-edge habitat with different spectral composition, replicated eight times. Monitoring of species is being performed according to rigid protocols, in part using a citizen-science based approach. Simultaneously, we look at alterations in behaviour, such as changes in activity, and daily and seasonal timing. In our setup, we have so far observed that experimental lights have effects on many bird species at the community level, which vary with spectral composition. Besides, we will present the effects on breeding behaviour and fitness components in two nest box breeding songbird species. The finding that light colour may have differential effects on birds opens up the possibility to mitigate negative ecological effects of nocturnal illumination with the use of different light spectra.

4. Contrasting changes in the abundance and diversity of North American birds

Aafke Schipper, Jonathan Belmaker, Murilo Dantas de Miranda, Henrique Pereira
Radboud University Nijmegen

National and international agreements to counteract the current global biodiversity decline call for biodiversity changes to be adequately quantified. However, biodiversity is multi-dimensional, including aspects of taxonomic, functional and phylogenetic diversity, and changes are not necessarily congruent among these dimensions. In the present study we used various biodiversity indices to quantify changes in bird assemblages in the contiguous United States between 2010 and 1970, using bird monitoring data from the North American breeding bird survey (BBS). Against our expectations, we found a slight increase in most biodiversity indices. This was, however, accompanied by a distinct decrease in total bird abundance. Further, the patterns of change were different among species of different habitat affinities, with both diversity and abundance increasing for woodland birds and decreasing for

grassland species. Thus, our findings underscore the relevance of considering multiple aspects of biodiversity simultaneously, and challenge the use of particular species groups as surrogates for overall biodiversity.

5. Individual stochasticity and variance in lifetime reproductive output in birds

Silke van Daalen, Hal Caswell
University of Amsterdam

Studies of lifetime reproductive output (LRO) in birds have repeatedly documented high inter-individual variance and positive skewness. This is often interpreted as a measure of the opportunity for natural selection. However, this interpretation is correct only if the variance reflects genuine heterogeneity, in particular heterogeneity with a genetic basis. It has been recognized recently that some fraction of the variance in LRO is due to individual stochasticity (random differences in the fates of individuals experiencing the same vital rates). Distinguishing this stochasticity from genuine heterogeneity is crucial for interpreting observations of LRO. Here, we present the first general analytical solution to the calculation of the variance and skewness of LRO from age- or stage-classified demographic data, and the first application of the method to bird species with a range of life histories. We find that individual stochasticity creates significant variability in LRO. In cases where data exist to make the comparison, most if not all of the observed variance in LRO in birds can be explained by individual stochasticity. To invoke heterogeneity in these cases would require additional data. Calculations of individual stochasticity should become part of any demographic study of birds.

6. Linking fire regimes and climate and biomass burning emissions at different scales in the tropical Andes

Callum Lawson, Yngvild Vindenes, Liam Bailey, Martijn van de Pol
Netherlands Institute of Ecology / Australian National University

Species are facing long-term environmental changes precipitated by global warming, but fluctuations in weather generate environmental variation on much shorter timescales. Such environmental variation may alter species' responses to global warming by subjecting individuals to more extreme and erratic changes in conditions. In this talk, I review recent theoretical and empirical population studies to assess (1) how changes in environmental variation will affect long-term rates of population growth, and (2) whether environmental variation affects the responses of populations to changes in average environmental conditions, such as increases in mean temperature. I end by discussing whether we can predict population responses to environmental variance in species for which detailed population surveys are unavailable.

3b: Recent Advances in Plant Mycorrhizal Research

Conveners: Hans Jacquemyn (KU Leuven)
Vincent Merckx (Naturalis Biodiversity Center)

1. Seedlings as Empty Islands: Order of Arrival Structures Arbuscular Mycorrhizal Colonisation of Plants

Gijsbert Werner, Toby Kiers
Vrije Universiteit Amsterdam

Priority effects – the impact of a species' arrival on subsequent community development have been shown to influence species composition in many organisms. Whether priority effects among arbuscular mycorrhizal fungi (AMF) structure fungal root communities is not well understood. To AMF, however, plant seedlings are 'empty islands' and there is strong competition among AMF species for colonisation of plant roots, suggesting arrival order could structure plant AMF communities. We studied if priority effects influence competition between two closely related AMF species, hypothesising that (1) a resident AMF suppresses invader success, (2) this effect is time-dependent and (3) a resident AMF will experience reduced growth when invaded. We performed two greenhouse experiments using modified pots enabling direct inoculation of resident and invading AMF species on the roots. Recently developed qPCR markers allowed us to discriminate and quantify intraradical AMF abundance of both strains and identify priority effects. We found that both species, even the one inferior in direct competition, can suppress the invasion of a later-arriving invader and that this effect is strongly dependent on the duration of the head-start. In contrast to our expectations, neither resident AMF was affected by invasion with the other. We show how these results are likely to be driven by plant downregulation of further colonisation. This suggests that historical contingencies, and not only intrinsic competitive qualities, determine which AMF plants can interact with symbiotically. This has important implications for plant and AMF ecology, as well as for potential use of AMF-inocula in sustainable agriculture.

2. Warming enhances termination of a phytoplankton spring bloom: Impacts of fungal parasites

Thijs Frenken, Mandy Velthuis, Lisette De Senerpont Domis, Ellen Van Donk, Dedmer Van de Waal
Netherlands Institute of Ecology

Global warming is expected to affect size and seasonal timing of phytoplankton communities and its infection by fungal parasites. It has furthermore been suggested that warming will reduce the development of epidemic chytrids. We tested the effect of warming on a natural phytoplankton community and its fungal parasite in a 1,000 L indoor mesocosm experiment. During the spring bloom the phytoplankton community was dominated by the diatom *Synedra.* Temperature was found to affect shape, magnitude and termination of the spring bloom. A lower diatom biomass developed in the warm treatment, as well as an earlier bloom termination. For the fungal parasite, the period of infection was longer at ambient temperatures, although prevalence of infection was comparable between both treatments. Such temperature-driven changes in fungal infections will presumably have consequences for other trophic levels, and thus affect cycling of carbon and nutrients through aquatic food webs.

3. Compositional shits in ectomycorrhizal fungal community in response to long-term snow depth manipulations

Luis Morgado, Tatiana Semenova, Jeffrey Welker, Marilyn Walker, Erik Smets, József Geml
Naturalis Biodiversity Center

Climate warming is inducing changes throughout the Arctic altering land, sea and atmospheric processes and interactions. Many of these changes could potentially amplify climate warming via positive feedbacks. Tundra responses to changes in climate include aboveground changes, such as reduction in albedo associated with shrub expansion and tree line advance, and shifts in ecosystem C cycling resulting from greater C fixation. Importantly, the net effects of these climate-induced changes are unresolved, in part because our understanding of belowground responses to changes in winter conditions are limited. Here we focus on the effects of increased winter precipitation, and as a consequence, increased winter soil temperatures during the cold season, in arctic ectomycorrhizal (ECM) fungal communities in dry and moist tussock tundra. For that purpose we analyzed DNA data generated by Ion Torrent sequencing of soil samples taken at a long-term (18-year) snow fence experiment set up in Toolik Lake, Alaska. The results pointed to a significant effect of the snow depth in the arctic ECM fungal community. In the dry tundra, both the community richness and composition were significantly altered. There was a particular and sharp decrease in richness in *Tommentella*, *Inocybe* and taxa with contact, short distance and medium distance smooth hyphal exploration types. On the other hand, *Cortinarius* richness did not change resulting in a proportional increase of taxa with medium distance fringe hyphal exploration type that has been argued to be able to scavenge the soil for recalcitrant N forms. On the moist tundra, only the community composition changed, richness did not, and there were strong OTU-specific responses to the altered conditions. Our findings indicate that ECM responses to deeper snow in winter are tundra-type dependent. The shifts in the ECM composition may accelerate tundra plant's ability to acquire growth-limiting resources and that the coupled changes in above- and belowground processes point to a synergistic relationships between vegetation and ECM fungi.

4. **The combination of plant characteristics and light availability shape the arbuscular-mycorrhizal community composition in plant roots**

Kadri Koorem, Ingmar Tulva, John Davison, Teele Jairus, Maarja Öpik, Martti Vasar, Martin Zobe, Mari Moora
University of Tartu / Netherlands Institute of Ecology

Majority of terrestrial plant species are associated with arbuscular mycorrhizal (AM) fungi. It is well documented that plants deliver carbon compounds to the fungi and receive nutrients in return but as there are numerous species among plant and fungal partners, it is unclear which factors determine AM fungal community composition in plant roots. We hypothesized that available light levels as well as photosynthetic ability of plant species shape AM fungal community composition in plant roots. We selected closely located forest and clearcut habitats with contrasting light availability for test sites and recorded photosynthetic parameters, shoot biomass and AM fungal community composition on five plant species, which are growing in wide range of habitats and five plant species which are specialized to forests. Results showed that in well-illuminated conditions, in clearcuts, plant species which grow in a wide range of habitats were able to increase their photosynthetic ability (measured as leaf mass area, light-saturated electron transport rate, shoot biomass) more than forest specialist plants. Total number of AM fungal taxa associated to generalist plant species, determined by 454-sequencing, also increased in clearcuts while forest specialist plants were associated to equally high number of AMF taxa in both habitats. Forest specialist plants therefore experienced shift in AM fungal community composition between habitats. We suggest that environmental conditions as well as the plant species ability to use available resources determine AM fungal community composition in plant roots.

5. **Mycorrhizal divergence and patchy distributions of mycorrhizal fungi in the soil contribute to co-existence of orchid species**

Michael Waud, Pieter Busschaert, Bart Lievens, Hans Jacquemyn
KU Leuven

Recent research has shown that within a given location co-occurring orchid species tend to occupy different areas and associate with different mycorrhizal fungi, suggesting that orchid mycorrhizal fungi may be unevenly distributed within the soil and thus impact the spatial distribution of orchids. However, at present very little is known about the diversity, abundance and spatial distribution of orchid mycorrhizal fungi in soil. In this study, we investigated spatial variations in fungal and orchid mycorrhizal communities present in the soil and on the roots of three co-habitating orchid species (*Anacamptis morio*, *Gymnadenia conopsea*, and *Orchis mascula*) using 454 amplicon pyrosequencing. Orchid mycorrhizal fungi were broadly distributed in the soil, although variations in community composition were strongly related to the host plant around which the samples were taken. Additionally, the diversity and abundance of orchid mycorrhizal fungi in the soil declined with increasing distance from orchid plants. These results suggest that the clustered distribution of orchid species may be explained by the patchy distribution of species-specific mycorrhizal associates. Whether orchid presence also supports fungal abundance remains unclear and calls for closer examination of this potentially proximity- or quantity-based interaction with finer resolution.

6. **From the origins of plant-fungal symbiosis to the future of mycorrhizas in Europe's forests**

Martin Bidartondo
Imperial College London

Our understanding of the past and present of plant-fungal symbioses is changing fast; I will highlight discoveries from two ongoing large-scale projects. Over the last few decades scientists have become increasingly certain that symbiosis with fungi was necessary for the initial colonization and ultimate success of plants on land - a success that transformed the biosphere and atmosphere. But, how ancient plants relied on fungi was poorly known. With new data collected across the world, we are showing that early lineages of land plants have a more distinctive and versatile fungal repertoire than expected. A dearth of information about fungi at large scales severely limits science, management, conservation and environmental policy worldwide. Nonetheless, fungi fulfil critical functional roles in our changing environments and represent a considerable proportion of terrestrial biodiversity. Through the analysis of ectomycorrhizas at intensively-monitored forests across Europe, we are generating baseline data for ectomycorrhizal fungi, identifying nitrogen pollution as one of the major drivers of ectomycorrhizal functional and taxonomic diversity, and revealing fungi that can be used as belowground indicators of environmental characteristics.

3c: Aquatic Ecology

Conveners: Kees Musters (Leiden University)
Steven Declerck (Netherlands Institute of Ecology)

1. Aquatic metacommunity ecology: where are we and where do we go

Steven Declerck
Netherlands Institute of Ecology

Metacommunity theory integrates the study of interactions between organisms and their local biotic and abiotic environment with spatial, dispersal-related dynamics at the regional scale. Since its introduction, the framework has inspired numerous empirical and theoretical studies that have yielded new insights into how spatial community patterns are generated and how biodiversity is maintained at both local and regional spatial scales. The framework has proven instrumental as a basis for the development of important conceptual innovations and new theoretical frameworks. Using examples from the aquatic literature, I will introduce the fundamentals of the theory and give an overview of important recent developments. I will stress the importance of understanding how organism traits and landscape features affect metacommunity dynamics and how this may feed back to the community structure and functioning of aquatic ecosystems. I will also make a link with new frameworks such as evolving metacommunities and meta-ecosystems.

2. Land use effects on ditch ecosystem biodiversity among different species groups

Sven Teurlincx, Amber Heijboer, Ellen van Donk, Steven Declerck
Netherlands Institute of Ecology

Land use change has a dramatic effect on the biodiversity at both small and large scales. To understand the effects of land use on species composition, attention needs to be given the variety of processes that play a role at the local level as well as at the landscape scale. This study aims to investigate how biodiversity in and around ditches of polder landscapes is shaped. By means of a large-scale field survey, we characterized aquatic communities and environmental conditions in a large number of ditch reaches (24 sites per polder) of three polder systems that varied in land use practice. By distinguishing local habitat conditions from spatial connectivity of the landscape we were able to gain insights into the metacommunity structure of different regions. Organism groups are likely to respond to land use in a different manner, depending on their ability to cope with fragmentation and changing environment. To address these differences and their implications for management, this study compared metacommunity structure of five groups of organisms (bank vegetation, helophytes, hydrophytes, zooplankton, soil microbes). The found differences between groups can possibly be attributed to contrasting functional traits (e.g. primary dispersal modes).

3. Context-dependency of pesticide impacts on freshwater macrofauna community structures in ditches

O. Ieromina, W.J.G.M. Peijnenburg, C.J.M. Musters, M.G. Vijver
Leiden University

Connected systems of ditches in the Netherlands are well known for their contribution to the function of water level control and drainage of the agricultural fields. Ditches are also important in terms of biodiversity, since many aquatic species find there suitable habitats. Aquatic biota in ditches is subjected to chemical stress due to the close proximity of ditches to agricultural fields where pesticides and fertilizers are used extensively. However, to what extent pesticides contribute to the overall variance in aquatic macrofauna communities in ditches is not well understood. The current research aimed to study context dependency of pesticide effects on aquatic macrofauna communities in ditches. To address the aim field work was performed in the agricultural area of the Netherlands during two years, that included collection and taxonomic identification of aquatic macrofauna, measurements of water chemistry parameters and pesticides. In addition, macrofauna taxa were classified according to 64 species traits. The total variance in macrofauna taxonomic and species trait community composition was divided into variance explained by pesticides, environmental factors, time and shared variance using variance partitioning procedure based on redundancy analysis (pRDA). The proportion of variance explained by all factors was similar between taxonomic and species trait approaches. The largest proportion of variance in macrofauna taxonomic groups was explained by environmental factors and presence of other biota, followed by time and pesticides. It can be concluded that context dependent factors contribute significantly to variances in aquatic biota along with pesticides.

4. An experimental test of the effects of hypoxia induced by floating vegetation on drainage ditch invertebrates

Ralf Verdonschot
Alterra - Wageningen UR

In small, lentic ecosystems in agricultural areas, eutrophication often results in excessive growth of small, free-floating plants. A dense layer of plants on the water surface changes the underwater light climate drastically and in turn leads to hypoxic or even anoxic conditions. Knowledge of the effects on macroinvertebrates of reduced light conditions and oxygen stress as result of eutrophication is limited. We thus examined in a field situation the influence of an unpredictable, 10-day period of low oxygen

availability as a result of poor underwater light conditions. In a before–after control–impact design, the underwater light climate and dissolved oxygen concentration of ditch sections were manipulated, and the macroinvertebrate assemblage composition was recorded during the 4 weeks before and after treatment. A poor underwater light climate in combination with normoxic conditions did not affect the invertebrate assemblage composition, but the combination of low-light intensity and anoxic conditions did alter it. Interestingly, these changes were not apparent directly after treatment but developed in the weeks following, indicating that although the invertebrates could cope with a shading-induced period of hypoxia, costs were associated with the event over a longer time period.

5. The role of mallards in the dispersal of plant seeds

Erik Kleyheeg, Merel Soons
Utrecht University

Facilitation of seed dispersal between isolated wetlands by waterbirds is increasingly recognized as a driving force behind the wide distribution of many aquatic plant species and rapid colonization of wetlands. Particularly mallard ducks (*Anas platyrhynchos*) are considered a major player in this process. However, little is known about the quantitative scale of waterbird-mediated dispersal and it is still unclear what determines survival of duck gut passage and how vector behaviour affects the dispersal potential of ingested organisms. To study this, we used a multidisciplinary approach, focusing the three main steps in endozoochorous dispersal: 1) propagule ingestion, 2) gut passage survival, and 3) transportation. For step 1 we analysed dabbling duck diets by literature review and carcass dissection. Ducks in Europe consume seeds of >400 species, indicating opportunistic foraging and little discrimination between plant species. For step 2 we experimentally tested the effects of mallard activity on gut passage survival of seeds. Digestion was less efficient in swimming than resting ducks and gut passage was slightly accelerated. Most seeds were retained in the guts for 2-4 hours, but maximum retention times exceeded 24 hours, suggesting dispersal potential of hundreds of kilometres during bird migration. For step 3 we obtained high-resolution GPS tracks of 102 mallards to assess their landscape-scale spatial behaviour, revealing highly repetitive circadian movement patterns between fixed roosting and foraging sites. Movement distances were negatively correlated with freshwater habitat availability. The increased understanding of the dispersal of plant seeds by waterfowl emphasizes the importance of ducks in ecosystem functioning.

6. The dark side of keystone mutualism: Mutualism breakdown triggers runaway landscape-scale degradation of seagrass beds

Jimmy de Fouw, Laura Govers, Johan van de Koppel, Marjolijn Christianen, Karin van der Reijden, Matthijs van der Geest, Theunis Piersma, Alfons Smolders, Han Olff, Leon Lamers, Jan van Gils, Tjisse van der Heide
Royal Netherlands Institute for Sea Research

It is increasingly realized that mutualisms form keystone interactions allowing high biodiversity ecosystems such as coral reefs and seagrass beds to persist in seemingly inhospitable environments. Yet, little is known of how the dependence of these rich ecosystems on mutualistic interactions shapes their dynamics and persistence, as mutualism breakdown would potentially have dramatic consequences. Here we report how the failure of a mutualistic network functioning at the plant rhizosphere-scale leads to degradation of intertidal seagrass beds at the landscape-scale in the Banc d'Argain, a Marine Protected Area (MPA) in West-Africa. We provide experimental evidence showing that the seagrass die-off is a consequence of breakdown of an omnipresent three-stage mutualistic interaction among seagrass, lucinid bivalves and their endosymbiotic gill-bacteria (Van der Heide *et al*, Science, 2012). Degraded seagrass patches contained low lucinid bivalve densities and enhanced levels of sulfide in the sediment compared to healthy seagrass areas. Experimental manipulation of lucinid densities revealed that that the loss of the mutualistic partner, triggered by desiccation stress, was the dominant factor explaining seagrass die-off. Our empirical results demonstrate that disruption of small-scale mutualistic interactions can cause rapid, landscape-scale habitat degradation in ecosystems where biodiversity and ecosystem functioning are critically dependent on these keystone interactions.

3d: Ecological Intensification of Agriculture

Conveners: Willemien Geertsema (Wageningen University)
David Kleijn (Wageningen University / Alterra)
Paul van Rijn (University of Amsterdam)

1. Ecological intensification of agriculture: Managing ecosystem services

Willemien Geertsema, Felix Bianchi, Walter Rossing, Joop Schaminee, Wopke van der Werf
Wageningen University

Ecological intensification of agriculture (EI) aims at balancing food security with improved environmental quality by maximizing reliance on ecosystem functionalities. Ecological intensification requires the redesign of agricultural landscapes that have become highly simplified over the past 50 years to strengthen the provision of ecosystem services that support crop production and make agriculture less dependent on chemical inputs. As a range of ecosystem services are determined by drivers that operate at multiple scales, changes in agricultural practices are needed at field, farm and landscape levels. These changes will require new social and economic collaborations, for instance to strengthen natural pest control and pollination which operate at landscape scales. The need for a transition in agricultural practices is increasingly recognized, and studies of the drivers of ecosystem services in the last decade reveal ample opportunities. Uptake of management actions is still limited; apparently the knowledge is insufficiently actionable. To become actionable, scientific knowledge development needs to become embedded in the social-ecological change processes that characterize EI. Such actionable knowledge makes generic insights locally specific, is responsive and pro-active to emerging knowledge demands, and fosters the legitimacy of the research process as part of the social transition processes. We identify four perspectives that represent key elements of knowledge content and knowledge application for ecological intensification of agriculture: biodiversity is the basis; spatiotemporal scales exceed individual farms and crop dynamics; multiple ecosystem services and multiple stakeholders are involved; institutional changes are part of ecological intensification of agriculture.

2. How complementary habitats can promote natural pest control

Paul van Rijn
University of Amsterdam

Natural pest control is an important ecosystem service provided by the collection of habitats making up agricultural landscapes. To improve the level and reliability of natural pest control, the complementary qualities of the various habitats and their distribution through the landscape is considered to be important. To underpin this statement, I modelled populations of aphids and their natural enemies in relation to habitat- and time-restricted resource patterns observed in arable landscapes. The natural enemies considered important (such as aphidophagous hoverflies) have different resource requirements during their juvenile and adult stage (prey and floral resources respectively) and during winter and summer. Assuming sufficient dispersal and searching abilities, the model predicts that crop aphid densities will be lowest when both prey and floral resources are continuously present in the local landscape during at least spring and summer. For the long-term persistence of the natural enemies suitable autumn and winter habitats should be present as well. By modelling various 'incomplete' landscapes, in which one or more habitats (or habitat qualities) are missing, the relative importance of the different habitats (or habitat qualities) for natural pest control can be quantified. This analysis indicates e.g. that in addition to various semi-natural habitats also crop fields (taking size into account) are important habitats, and that cropping patterns can affect natural pest control as well. When applied to specific landscapes the model can indicate which landscape measures are most effective in restoring natural pest control. As the timing of the resource availability is very important, the model can also be used to predict the optimal timing for i.e. sowing annual field margins, mowing road sides and even applying pesticides. The various predictions can be used to validate the model, either experimentally of by large-scale ecosystem service monitoring programs.

3. Temporal niche differentiation and productivity increase in intercrops

Yang Yu, Tjeerd-Jan Stomph, David Makowski, Wopke van der Werf
Wageningen University

The land equivalent ratio (LER) characterizes the productivity advantage in intercrops. We hypothesized that temporal complementarity, i.e. a difference in seasonal patterns of resource acquisition and growth between component species, is a key factor driving high LER. First, we operationalized the concept of temporal niche differentiation by defining an indicator TND as the proportion of the total growth duration of the whole system (from sowing of the first crop to harvest of the last) that the component species are not overlapping. Secondly, we searched the literature and extracted 746 data records from 100 papers out of a total of 921 publications that were checked against inclusion criteria. Meta-analyses were conducted with mixed effects models to account for nested data. LER increased with TND. This increase was strong for intercrops that consisted of a mixture of a C3 and a C4 species but shallow for intercrops that consisted of C3 species only. Nitrogen fertilizer interacted with the effect of TND on LER. At low or zero TND, LER decreased with fertilizer amount, whereas at large TND, LER increased with fertilizer amount. This meta-analysis highlights the benefit of combining C3 and C4 species that together extend the growth duration and productivity of the crop system.

4. Yield, growth dynamics and plastic outcomes of competitive interactions in wheat-maize intercropping in the Netherlands

Fang Gou, Guoyu Wang, Martin van Ittersum, Peter van der Putten, Wopke van der Werf
Wageningen University

Intercropping is widely used by smallholder farmers in developing countries. Advantages compared to sole crops include greater yield per unit area, improved nutrient uptake and reduced nutrient losses, greater carbon sequestration in soil, and enhanced natural suppression of pests and diseases. There is little experience with intercropping of food crops in Western Europe. Intercropping is, however, gaining more attention for its potential to strengthen ecological services in agriculture. Yields in intercrops depend on interactions between planting patterns of mixed species and local growing conditions. Here we studied yield and yield components in the wheat-maize intercrop system in different planting patterns. Field experiments were conducted in 2013 and 2014 in Wageningen, the Netherlands. Treatments included sole crops of wheat and maize, as well as replacement intercrop (6:2 WM), and additive or subtractive designs, based on skip-row (6:0 WM, 0:2 WM) and add-row (6:3 WM, 8:2 WM) manipulations. Land equivalent ratio (= relative yield total) of intercrops varied from 1.21 to 1.30 in 2013 and from 0.96 to 1.08 in 2014, demonstrating on average positive niche complementarity between wheat and maize but also large differences in performance between different intercrop configurations in different years. Wheat grown in the border rows of wheat strips, neighbouring on maize or skip rows, experienced relaxed competition during early growth and had higher ear number per meter row and greater kernel number per ear than wheat in inner rows and monoculture. Wheat in intercrop had, however, reduced kernel weight and harvest index in border rows as a result of greater competitive dominance of maize during the grain filling stage of wheat. Maize grown in skip-row treatment had significantly greater yield per plant and kernel weight as compared to sole maize, while intercropping had a negative effect on maize biomass accumulation and kernel weight, especially in add-row treatments. This study demonstrates that yield advantage of intercropping occurs under Western growing conditions, and elucidates the dynamics and plastic outcomes of competitive interactions in a simple two-species system.

5. Quantifying pollination services by wild insects for Dutch fruit crops

Arjen de Groot, Ruud van Kats, Menno Reemer, Koos Biesmeijer, David Kleijn
Alterra - Wageningen UR

Insect pollinators are of large value for fruit and vegetable production and have become a well-known illustration of the ecosystem services concept. Reported population declines of managed pollinators have drawn attention to the potential role of wild pollinators in food production. Yet, the relative contribution of wild bees may depend on crop type, as well as local bee community composition and climatic conditions. Quantification of this contribution has merely been attempted under experimental conditions and rarely assessed how pollination benefits translate into economic value. In a comparative study at 15 fruit farms per crop during two consecutive years, we assessed relations between bee community composition and agronomic and economic fruit yield at the farm scale, for economically important races of apple and blueberries in the Netherlands. We found that insect pollinators strongly enhance both fruit set and fruit quality, and contribute to a significant part of the income raised by apple and blueberry growers. In contrast with recent literature we did not find any relations between local pollinator abundance or species richness, and apple quality. For blueberries we showed that fruit set was affected by the abundance of honey bees only, while fruit quality related to the amount and diversity of wild pollinators. Our results seem to support recent findings that provision of ecosystem services may not always require a high diversity of service providing communities.

6. Seeking preconditions for system shifts in agricultural social-ecological systems

Anouk Cormont, Carla Grashof, Nico Polman, Eugene Westerhof, Jappe Franke, Paul Opdam
Alterra - Wageningen UR

Multifunctional farm systems produce ecosystem services for the benefit of the farmer or of other actors. They are considered to be more resilient to changing conditions like economic shocks in the market price or to ecological shocks like weather extremes, compared to farm systems producing only for the world food market. The concept of complex adaptive systems (CAS) is used to learn how economic, social and ecological factors influence farmers to shift from conventional to multifunctional farming or vice-versa. Using a cellular automata model we studied the development of the number and spatial pattern of stylized potato farms investing in green infrastructure (flower strips) for natural pest regulation in a virtual agricultural landscape. Natural pest regulation is assumed to be only effective if sufficient neighbouring farms also invest in flower strips. We also assume that farmers have different mind-sets towards economic, social and sustainability values. Results of a linear forward stepwise regression analysis of 15 runs of 1000 random parameter settings show that low costs of green infrastructure application is a very important factor for farmers to decide to switch or continue to multifunctional farming, both in a conventional or multifunctional landscape. Moreover, in a conventional setting, another important factor to shift to multifunctional farming is the natural drive of farmers towards multifunctional farming, In a multifunctional setting however, the most important factor to stay multifunctional is the strength of the existing social structure of (multifunctional) farms.

Parallel Session 4

4a: Biodiversity in Time and Space

Conveners: Daniel Kissling (University of Amsterdam)
Niels Raes (Naturalis Biodiversity Center)

1. Integrative macroecology: Understanding the history of biodiversity

Daniel Kissling
University of Amsterdam

Large-scale variation in biodiversity is often highly correlated with contemporary environment which makes it difficult to understand historical legacies. Here I advocate for a stronger integration of historical data into macroecological analyses of species richness and assemblage composition. A fundamental first step for this research field is to compile and digitize comprehensive quality-checked data on species occurrences (e.g. distribution records, range maps, inventory data etc.) which can then be used to describe and predict macroecological (i.e. continental and global) patterns of biodiversity and assemblage structure. Such distributional data then need to be integrated with paleoclimatic simulations, phylogenies, biome reconstructions and geology to understand the role of in-situ diversification, geographic isolation, and long-term (deep-time) habitat and climate stability for the origin, generation and maintenance of biodiversity. The establishment of comprehensive datasets on ecological and life-history traits (e.g. diet, body size, growth forms, leaf traits etc.) will further allow more mechanistic insights into the dynamics of diversification through space and time, and into the importance of ecological adaptations and species interactions for shaping global patterns of species coexistence.

2. Differences in species richness patterns based on widespread vs. narrow-ranged species: the botanical diversity of Gabon

André van Proosdij, Niels Raes, Jan Wieringa, Marc Sosef
Naturalis Biodiversity Center / Wageningen University

Patterns of species richness based on widespread species are thought to differ from such patterns based on narrow-ranged species, but a formal assessment of this hypothesis is still lacking. Species Distribution Modelling (SDM) offer opportunities to infer diversity patterns for data-sparse regions such as tropical Africa. Here, we applied SDM methods to infer for the first time patterns of plant species richness and weighted rareness in the botanically rich Central-African country Gabon. We test if diversity patterns based on widespread species indeed differ from patterns based on narrow-ranged species. SDM's of all 5000 Gabonese plant species are based on 200.000 available herbarium records from tropical Africa. By applying for each raster cell a threshold for the habitat suitability, each SDM results in a presence–absence map. By superimposing these individual species' presence-absence maps, and summing the total of predicted species' presences per raster cell, species richness maps are generated for resp. widespread, narrow-ranged, and all species. The predicted species' range is used to calculate the species' rareness, resulting in a weighted rareness diversity map following the same procedures. Our results show that diversity patterns based on widespread species differ from patterns based on narrow-ranged species and underestimate species richness in centres of diversity. Acknowledging this difference will help setting priorities in conservation. Further, our results identify the Crystal Mountains and Chaillu Massif as the botanically most species rich areas of Gabon, confirming previously published theories. The hypothesized high species richness of the coastal Doudou mountains is confirmed here.

3. Local scale soil biodiversity patterns in New York City's Central Park are comparable to those observed globally

Kelly Ramirez, Jonathan Leff, Albert Barberán, Diana Wall, Noah Fierer
Netherlands Institute of Ecology

The majority of earth's biodiversity lives in and makes up the soil, but the majority of soil biodiversity has yet to be characterized or even quantified. Further, we still lack a complete understanding of belowground biodiversity patterns from local to global scales. Here we describe a study to examine the total soil biodiversity - Bacteria, Archaea and Eukarya- of Central Park, New York City and test for patterns of distribution in relation to the soil environment and aboveground drivers. We then compare the biodiversity and biogeography of soil communities of Central Park to global soils, spanning a number of biomes from Alaska to Antarctica. To generate a broad-scale survey of total soil biodiversity, 596 soil samples were collected from across Central Park (3.41 km2) and 57 additional soils were collected from across the globe. Using high-throughput Illumina sequencing technology we characterize the complete soil community from 16S rRNA (Bacteria and Archaea) and 18S rRNA gene sequences (Eukarya), and define phylotypes ("species") as taxa that share ≥97% sequence similarity. We found high biodiversity in Central Park, the majority of which was undescribed (over 120,000 bacterial species, and over 40,000 eukaryotic species). Additionally, the taxonomic and phylogenetic diversity observed in central park are very similar to those observed in global soils, with up 75-95% of species shared between Central Park and the global soils. Further, as observed at the global scale, pH is the strongest predictor of soil community patterns across Central Park, while geographic distance

and vegetation show no relationship. Taken together, these results demonstrate that belowground diversity is structured by different controls than aboveground diversity. Overall, our data suggest that even well-studied locations like Central Park harbor very high levels of unexplored biodiversity, and the breadth of soil biodiversity found in Central Park is comparable to biodiversity found in soils globally.

4. Global long-term ecological trajectories, dynamics and reorganizations

William Gosling
University of Amsterdam

Most extant species on Earth had evolved by the start of the Quaternary (c. 2.6 million years ago). The Quaternary period, in geological terms, is considered as an “icehouse” with extensive glaciers expanding from the poles for the majority of the time. Quaternary “glacial” conditions have however been periodically punctuated by warmer (c. +4-6^{o}C) “interglacial” conditions concomitant with variation in the Earth’s orbital configuration (on c. 40,000 or 100,000 year timescales). These major climate perturbations (glacial-interglacial cycles) resulted in the repeated reorganization of ecological communities on a global scale, and played a major role in determining modern biogeographic patterns. An insight into how terrestrial ecosystems were perturbed by glacial-interglacial cycles can be obtained from the study of fossil records from lake sediments. However, lake sediments old enough to provide information from beyond the current warm interglacial period are globally scarce, and logistically difficult to obtain. Comparison of evidence for past vegetation change (fossil pollen) obtained from multiple lakes spanning at least one full glacial-interglacial cycle reveals: (i) the uniqueness of assemblage compositions of each interglacial period, (ii) the highly dynamic nature of vegetation assemblages during individual interglacial periods, (iii) the similarity of trajectories of change between interglacials, and (iv) the consistency in the patterns of change at different altitudes and latitudes. The heterogeneity of the past ecological records highlights the spatial complexity of ecosystems response to high magnitude rapid global climate change.

5. Historical distribution of Sundaland’s Dipterocarp rainforests at Quaternary glacial maxima

Niels Raes, Charles Cannon, Robert Hijmans, Thomas Piessens, Leng Guan Saw, Peter van Welzen, Ferry Slik
Naturalis Biodiversity Center

The extent of Dipterocarp rainforests on the emergent Sundaland landmass in Southeast Asia during Quaternary glaciations remains a key question. A better understanding of the biogeographic history of Sundaland could help explain current patterns of biodiversity and support the development of effective forest conservation strategies. Dipterocarpaceae trees dominate the rainforests of Sundaland, and their distributions serve as a proxy for rainforest extent. We used species distribution models (SDMs) of 317 Dipterocarp species to estimate the geographic extent of appropriate climatic conditions for rainforest on Sundaland at the last glacial maximum (LGM). The SDMs suggest that the climate of central Sundaland at the LGM was suitable to sustain Dipterocarp rainforest, and that the presence of a previously suggested transequatorial savannah corridor at that time is unlikely. Our findings are supported by palynologic evidence, dynamic vegetation models, extant mammal and termite communities, vascular plant fatty acid stable isotopic compositions, and stable carbon isotopic compositions of cave guano profiles. Although Dipterocarp species richness was generally lower at the LGM, areas of high species richness were mostly found off the current islands and on the emergent Sunda Shelf, indicating substantial species migration and mixing during the transitions between the Quaternary glacial maxima and warm periods such as the present.

6. Deep-time (0.1-10 My) dynamics of oceanic islands affect species richness

Kenneth Rijsdijk, Sietze Norder, Daniel Kissling, Emiel van Loon, Rudy Otto, Brent Emerson, José Maria Fernández-Palacios
University of Amsterdam

We review the role of deep-time dynamics for biodiversity on oceanic islands. Volcanic hotspot islands rise and fall and their dynamics are caused by plate velocity and crustal rigidity. Plate tectonics can cause the long-term in-situ movement of biota on oceanic islands. Subsequent collisions of islands can lead to new colonisations by paleoendemics and to diversification of ancient colonists, with a strong influence on present-day phylogenetic patterns. The general dynamic theory postulated by Whittaker predicts that insular species richness shows a parabolic relationship with age as a function of changing carrying capacity over time (10 My). Using Linear Mixed Models with a data set comprising 68 oceanic islands, we demonstrate that island age shows a negative relationship with endemic terrestrial gastropod richness but a positive relationship with non-endemic native species. We suggest that this pattern results from the effect of erosion-reduced topographic complexity on older islands. When quantifying the effect of Pleistocene sea level changes (0.1 My time scale) we further find that island surface area change and past connectedness of islands (which were joined due to lower sea levels in the Pleistocene) explains both endemic species richness as well as the number of insects and plant species shared by islands that were merged in the Pleistocene. We highlight the importance of geology and paleoclimate for the general dynamic equilibrium theory and demonstrate how an understanding of deep-time dynamics (0.1-10 My) is crucial for explaining current biodiversity on oceanic islands.

4b: The Dynamics of Ecotones

Conveners: Imma Oliveras (Wageningen University)
Maarten Eppinga (Utrecht University)
Matty Berg (Vrije Universiteit Amsterdam)

1. The Dynamics of Ecotones: An overview

Han Olff
University of Groningen

2. Who needs fire

Jon Lloyd, Elmar Veenendaal, Imma Oliveras
Imperial College

Dogma emerging over recent years has it that there exists a wide climatic domain where either forest and savanna can exist. This potential for co-existence has been argued to be maintained through the presence of alternative stable states (ASS) mediated by fire. Here we show that, whilst the wide climatic domain concept may be correct, fire mediated feedbacks may not be required to account for large variations in tropical vegetation structure across that domain. Rather – as we show using data from three continents – all that is needed to account for this apparent complexity is a dual consideration of soil nutrients and soil water storage/precipitation interactions.

3. Shrub decline instead of shrub expansion in Arctic lowland tundra?

Monique Heijmans, A.L.Nauta , D. Blok, J. Limpens, B. Li, P. Wang, J. van Huissteden, T.C. Maximov, F. Berendse
Wageningen University

Arctic tundra ecosystems are characterized by low vegetation and permanently frozen ground (permafrost). Permafrost thaw and the resulting release of greenhouse gases from decomposing soil organic carbon has the potential to accelerate climate warming. In recent decades, tundra shrub expansion has been observed in many places, in response to changing climate conditions. However, in our long-term field experiment at a Northeast-Siberian tundra site we have observed that the lowland tundra ecosystem is extremely vulnerable to increased thawing, e.g. due to disturbance, leading to thaw pond development and shrub decline. Removing the shrub part of the vegetation in the experiment initiated thawing of ice-rich permafrost, resulting in collapse of the originally elevated shrub patches into waterlogged depressions. If permafrost thawing can more frequently trigger such local permafrost collapse, methane-emitting wet depressions could become more abundant in the lowland tundra landscape, at the cost of permafrost-stabilizing low shrub vegetation, particularly in poorly-drained ice-rich permafrost regions. Shrub decline associated with increasing wetland extent seems an underestimated trajectory in response to climate warming, but would be in line with reports of lake expansion, and drowning larch trees close to the treeline in Siberian lowland tundra.

4. Savannas at the transition between forests and grasslands: modelling ecological processes at the continental scale

Mara Baudena, S. C. Dekker; P. van Bodegom; B. Cuesta; S. Higgins; V. Lehsten; C. Reick; M. Rietkerk; S. Scheiter; Zun Yin; M.A. Zavala; V. Brovkin
Utrecht University

Savannas are the central biome in the transition between grasslands and forests, cover about a fifth of the Earth land surface, and have wide socioeconomic importance regarding land use and biodiversity. They are characterized by the coexistence of two types of vegetation: trees (i.e. woody vegetation), and grasses (i.e. grasses and herbs). For a long time ecologists have been fascinated by savannas, and numerous fields and modelling studies explored the nature of tree-grass competition and coexistence. Drawing on the large number of recent studies that have delivered new insights into the ecology of tropical ecosystems in general, and of savannas in particular, we now identify two main mechanisms that need to be included when modelling the dynamics of this transition. The first mechanism is water limitation to tree growth (and tree-grass competition for water), which is a key factor in determining savanna presence in arid and semi-arid areas. The second is a grass-fire feedback, which maintains both forest and savanna occurrences in mesic areas. Grasses constitute the majority of the fuel load, and at the same time benefit from the openness of the landscape after fires, since they recover faster than trees. Additionally, these two mechanisms are better represented when the models also include tree life stages (adults and seedlings), and distinguish between fire-prone and shade-tolerant savanna trees, and fire-resistant and shade-intolerant forest trees. Savannas are expected to undergo major changes in the future, due to global climate change. Dynamic Global Vegetation Models (DGVMs) are very useful to understand vegetation dynamics under present climate, and to predict its changes under future conditions, at continental to global scale. To what extent are the abovementioned mechanisms included in this type of models? In an attempt to bridge the knowledge gap between ecology and global modeling, here we perform a comparative analysis of three different DGVMs (JSBACH, LPJ-GUESS-SPITFIRE and aDGVM), where model outcomes, obtained including different mechanisms, are compared to observed tree cover along a mean annual precipitation gradient in Africa, with the aim of

identifying basic elements that could improve the predictive ability of the DGVMs, not only under current climate conditions but also and especially under future scenarios.

5. **Shrub- tree interactions in boreal and subarctic ecosystems: Paving the way for forest advance?**

Milena Holmgren, Juul Limpens
Wageningen University

Arctic and boreal ecosystems are warming twice as fast as the global average. Shrub and trees have expanded northward and started environmental changes that seem to speed up regional warming. Understanding the mechanisms that explain woody expansion remains fragmented. We conducted a series of field experiments in boreal and subarctic peatlands to assess the mechanisms that explain tree seedling recruitment and estimate the strength of positive feedbacks between shrubs and trees. Our results suggest that shrubs facilitate tree colonization of boreal and subarctic peatlands. These facilitative effects seem to be stronger under harsher abiotic conditions. In boreal systems, we have evidence of a positive feedback in which shrubs facilitate trees and in turn these further enhance shrub conditions. These results indicate that shrubs are paving the way for greener tree dominated landscapes in the far northern hemisphere.

6. **Consumer-driven nutrient cycling determines plant nutrient limitations in African savannas**

Michiel Veldhuis, Anneleen Hulshof, Matty Berg, Han Olff
University of Groningen

Ecotones, the transition area between multiple biomes, are often characterized by complex dynamics, resulting from multiple agents characteristic for each biome that altogether affect ecosystem processes. Nutrient cycling, one of these processes, might differ between the biomes (open vs closed systems, different consumers/decomposers) which is expected to affect nutrient limitations within the ecotone. Historically, research on plant nutrient limitations has focused on external factors like geology, substrate age and differences in external inputs and how plants cope with these nutrient limitations. However, the emerging field of ecological stoichiometry has shifted the focus towards biotic factors determining plant nutrient limitations, i.e. consumer-driven nutrient recycling. This latter approach becomes especially interesting for ecotones, where the different consumers linked to each biome might affect total ecotone nutrient cycling. Therefore, the question arises to what extent plant nutrient limitation in ecotones is determined by internal (nutrient cycling) and external factors (parent material, rainfall). Here, we show that in savanna ecosystems the internal factors determine nutrient limitation of plant functional types. Furthermore we show that plants that are part of an open cycle (lawn-herbivore, bunch-fire) are more nitrogen limited while closed cycles (woody species-detritivores) are co- or phosphorus limited. We suggest that the constant loss of nitrogen through ammonia volatilization (herbivores) or N_2 emission (fire) prevents build-up of nitrogen into the system, resulting in a nitrogen limited vegetation. These results help to understand the patterns of nutrient limitations found worldwide that are currently debated and to make predictions on the outcome of the battle of biomes within ecotones under changing environmental conditions.

4c: Ecology and Phytochemistry

Conveners: Kirsten Leiss (Utrecht University)
Colette Broekgaarden (Utrecht University)

1. An eco-metabolomic approach to study plant defense

Kirsten Leiss, Young Choi, Peter Klinkhamer
Leiden University

Secondary metabolites form the basis of plant defence. Therefore, we developed the eco-metabolomic approach to identify candidate compounds related to host plant resistance using NMR (Nuclear Magnetic Resonance Spectroscopy) (Leiss et al., 2011). We classify resistant and susceptible plants using *in-vivo* bioassays. Subsequently, we compare their metabolomic profiles by multivariate statistics to identify metabolites involved in host plant resistance. The negative effect of the candidate compounds is validated with *in-vitro* bioassays. As a proof of principle we used western flower thrips (*Frankliniella occidentalis*) a key pest worldwide. We applied the approach in different host systems including Senecio as a wild plant, chrysanthemum and gladiolus as ornamentals and tomato and carrot as vegetables. Different metabolites resulting from this approach are discussed in relation to their effect on thrips regarding their single and combined effects, their spatial and temporal distribution in the plant and their effect in different plant development stages.

2. Testing the generalist-specialist dilemma: The role of pyrrolizidine alkaloids in resistance to invertebrate herbivores in *Jacobaea* species

Xianqin Wei, Klaas Vrieling, Patrick Mulder, Peter Klinkhamer
Leiden University

Plants produce a diversity of secondary metabolites (SMs) to protect them against generalist herbivores. On the other hand specialist herbivores use SMs for host plant recognition, feeding and oviposition cues, and even sequester SMs for their own defense. Therefore plants are assumed to face an evolutionary dilemma from the contrasting effects of generalist and specialist herbivores on SMs. To test this hypothesis, bioassays were performed with F2 hybrids from *Jacobaea* species segregating for their pyrrolizidine alkaloids (PAs), using a specialist flea beetle (*Longitarsus jacobaeae*) and a generalist slug (*Deroceras invadens*). Our study demonstrated that slug feeding damage was negatively correlated with the concentration of total PAs and that of senecionine-like PAs while the flea beetle feeding damage was not affected by PAs. Flea beetle feeding was positively correlated with leaf fresh weight. We found that the generalist slug was deterred by senecionine-like PAs while the specialist flea beetle was adapted to PAs in its host plant. Other herbivores tested in the same plant system showed that the egg number of the specialist cinnabar moth was positively correlated with jacobine-like PAs, while the silver damage of generalist thrips was negatively correlated with senecionine- and jacobine-like PAs, and the pupae number of generalist leaf miner was negatively correlated with otosenine-like PAs. Therefore the specialist herbivores were not correlated or positively correlated with PA concentration, while the generalist herbivores all showed a negative correlation with the concentration of at least one type of PAs. We concluded that the generalist herbivores were deterred by different structural groups of PAs while the specialist herbivores were attracted or adapted to PAs in its host plants.

3. Plant-soil feedback effects on plant chemistry and performance of aboveground herbivores

Martine Kos, Martijn Bezemer
Netherlands Institute of Ecology

Plants can influence the (a)biotic conditions of the soil they grow in, which in turn, can lead to changes in the performance of plants that grow later in the soil. This process is named plant–soil feedback (PSF). PSF studies have typically focussed on effects on plant biomass, but it was shown recently that PSF effects can also change aboveground plant–insect interactions via soil-mediated changes in plant chemistry. However, it is unknown whether these effects depend on the identity of the plant species that conditioned the soil, and whether they are influenced by soil nutrient availability. We performed a series of greenhouse experiments to examine how PSF effects of a range of plant species influence the growth and primary (amino acid) and secondary (pyrrolizidine alkaloids) chemistry of ragwort (*Jacobaea vulgaris*) and the performance of specialist and generalist aphids, and whether fertilisation influences these PSF effects on aboveground plant-aphid interactions. We observed that different plant species, via species-specific effects on soil fungal communities, exerted different plant-soil effects on *J. vulgaris* biomass, amino acid concentrations in phloem exudates and aphid performance. Furthermore, we observed a strong interaction between soil conditioning and fertilisation on amino acid and pyrrolizidine alkaloids concentrations and on aphid performance, with opposite effects of soil conditioning at the two fertilisation levels. We provide novel evidence that PSF effects on plant chemistry and aphid performance are highly species-specific, and that fertilisation can even cause a reversion of the PSF effect on aboveground plant-insect interactions.

4. The other side of the coin – can P-addition alleviate nitrogen stress under nutrient poor conditions?

Anneke Kroes, Jeltje Stam, Erik Poelman, Joop van Loon, Marcel Dicke
Wageningen University

Plants respond differently to single or multiple herbivory, which results in a different plant phenotype. The ecological consequences of these differences in plant phenotype on yet another arriving herbivore have not been studied in great detail. Moreover, these responses might differ between plant populations. We tested the effects of single or multiple herbivory of *Brevicoryne brassicae* aphids and *Plutella xylostella* caterpillars on defences of three populations of wild cabbage plants, and the response of a subsequent arriving generalist herbivore, *Mamestra brassicae*. For both *B. brassicae* and *P. xylostella*, the performance was worse when feeding simultaneously with the other herbivore, compared to feeding alone. Subsequent arriving *M. brassicae* caterpillars had lower weight on plants previously induced by both *P. xylostella* and *B. brassicae* compared to on plants without previous insect feeding. We investigated if JA- and SA-signalling were activated differently by aphids or caterpillars alone or when both were feeding simultaneously. Aphids feeding alone and both insects feeding simultaneous induced the expression of *LOX2*. Interestingly, the level of SA was significantly lower in plants simultaneously induced with both insects compared to plants induced with aphids or caterpillars alone. This indicates that dual insect attack led to a different defence response compared to single insect attack. Furthermore, as transcript levels of LOX2 and PR-1 differed between wild cabbage populations, induced defences might not be fixed among plants. Thus, these results suggest that multiple herbivore feeding differently activates plant defence responses, which has plant-mediated negative consequences for a subsequent arriving herbivore.

5. Defense suppression benefits herbivores that have a monopoly on their feeding site but can backfire within natural communities

Joris Glas, Juan Alba, Sauro Simoni, Carlos Villarroel, Marije Stoops, Bernardus Schimmel, Robert Schuurink, Maurice Sabelis†, Merijn Kant
University of Amsterdam

Plants respond to herbivory by inducing defenses, mediated by the plant hormones jasmonic acid (JA) and salicylic acid (SA). Some herbivores have adapted to suppress plant defenses but how this affects herbivore communities is still an largely unexplored question. We observed that spider mites (*Tetranychus urticae*) reach higher densities on plants coinfested with tomato russet mites (*Aculops lycopersici*) in the field. In addition, using laboratory assays, we found that spider mites display increased reproductive performance on plants with russet mites. We show that russet mites manipulate tomato (*Solanum lycopersicum*) defenses which explain these observations: they induce those that depend on salicylic acid (SA) but suppress JA-dependent responses, to which russet mites are susceptible. Spider mite-induced JA-responses were suppressed on wild-type plants infested with both mite species but this did not happen on SA-deficient tomatoes, indicating that plant-mediated facilitation of spider mites by russet mites depends on the antagonistic effect of SA on the JA-pathway. In contrast, JA-responses induced by russet mites alone were absent in wild-type as well as in SA-deficient plants indicating that russet mites suppress JA-defenses independent from SA. Finally, we found that facilitation of spider mites results in an inhibition of the russet mite's own population growth, indicating that the benefits of defense suppression can backfire in the presence of competing species. We conclude that whether or not host-defense manipulation will lead to an improvement of an herbivore's fitness strongly depends on interactions with other species and the defenses each of them induce in their shared host.

6. Plant primary metabolites assembling as natural deep eutectic solvents and their possible role in drought- and freeze-tolerance

Evelien Rozema, Yuntao Dai, Rob Verpoorte, Young Choi
Leiden University

Natural deep eutectic solvents (NADES) are composed of common natural compounds, such as malic acid, citric acid, choline, amino acids and sugars such as sucrose. When mixed in a certain molar ratios the individual solid compounds interact by hydrogen bonds and form a liquid NADES, each with unique solubilization properties, particularly for many natural products with poor water solubility. Water is often part of the structure and very strongly retained, being part of the molecular network formed via hydrogenbonding. Primary metabolites are upregulated in plants in response to abiotic stresses such as drought or cold.The physico-chemical properties of NADES, such as the liquid-state even below -20 °C, a virtually zero vapor pressure, non-flammability and a high thermal and chemical stability may serve as mechanisms for phenomena in living cells such as drought- and freeze-tolerance. Concentrations of solutes and ions in cells increase with the loss of bulk free water. We screened different organisms that can survive dehydration like seeds, mosses, resurrection and desert plants and detected NADES components, including sugars, some amino acids, choline and citric acid. Interaction of NADES with membranes, vesicles and protein (complexes) may enhance their stability, dynamics and barrier properties. More data support now that it may be essential for survival of living cells under drought conditions and extreme temperatures to form NADES to maintain cell structure, retain water and to protect from freezing. NADES also could provide the environment in a cell for the biosynthesis of the many non-water soluble compounds including macromolecules.

4d: Ecology in Practice

Conveners: Wolf Mooij (Netherlands Institute of Ecology)
Margje Voeten (HAS Den Bosch)

1. Nuisance macrophyte species: An unavoidable phase in restoration?

Michiel Verhofstad, Elisabeth Bakker
Netherlands Institute of Ecology

Submersed macrophytes are of great importance for the functioning of many processes, both trophic and non-trophic, in shallow lake ecosystems. Following eutrophication submersed macrophytes first increase in some cases, but with ongoing eutrophication free floating macrophytes and algae often became dominant. Restoration management has focused on reducing the amount of available nutrients in the lake, which has led to a strong improvement of water quality in Dutch lakes. When nutrients in the water layer are low again, algae and free floating macrophytes can no longer outcompete submersed macrophytes which then can reappear. However, it is not easy to restore species-rich submerged vegetation as some rooted macrophytes can grow rapidly and form dense nuisance vegetation often consisting of one or just a few dominant species. In order to manage these aquatic systems successfully we need to understand under which conditions this happens. We hypothesized that the risk of nuisance rooted macrophyte growth is particularly high under conditions of clear water, and thus high light availability, combined with a high amount of available nutrients in the sediment, as these are ideal conditions for rooted macrophytes to grow. We visited 15 lakes in The Netherlands of which most have undergone restoration management. We measured vegetation parameters, water and sediment characteristics three times during 2013. We determined which macrophyte species can become a nuisance and at what time of the year. We identified several classes of potential nuisance growth, depending on the potential users of the water bodies, and related the risk of nuisance growth to water and sediment characteristics. Furthermore, we conducted a germination experiment with sediment from the lakes which shows that in most cases there are several species present as viable propagules. This indicates that once nuisance macrophytes diminish, either through time or after management, there can still be potential for a more diverse submersed vegetation to reappear.

2. Counteracting land subsidence by sod-cutting; combined effects of restoration measures on C-fluxes and *Sphagnum* re-growth in former agricultural peatlands

Sarah Harpenslager, Eva van den Elzen, Martine Kox, Katharina Ettwig, Leon Lamers
Radboud University, Nijmegen

Drained peatlands often are subsiding, which, with rising sea water levels, poses a risk to public safety. Furthermore, these degrading peatlands often form sources of C, thereby contributing to global warming. To counteract land subsidence it is necessary to re-wet the system, using either rainwater or surface water. This latter source, may, however, be of poor quality, which may not only affect the biogeochemistry and C-dynamics of the system, but also have a strong influence on the vegetation. Furthermore, since many systems were drained for agricultural purposes, the topsoil is often loaded with nutrients and the original peat-forming vegetation has usually disappeared. Since the ultimate goal of counteracting land subsidence would be to restore the accumulation of peat, restoration of peat-forming vegetation is highly important. Restoration of large areas is a costly operation and since previous large scaled projects have not always had the desired effect, it is useful to test measures on a smaller, controlled scale. We therefore carried out different combinations of restoration measures in a controlled laboratory setting, including sod-cutting, re-wetting with water of different qualities (rich in phosphate and/or bicarbonate) and re-growth of *Sphagnum*. We show a strong decrease in both CH_4 emission and nutrient mobilisation after sod-cutting. Furthermore, we found that the quality of the water used for re-wetting strongly influences biogeochemistry, C-fluxes and performance of *Sphagnum*, especially when the water contains high levels of bicarbonate

3. The challenge of mussel bed restoration

Hélène de Paoli, Tjisse van der Heide, Aniek van den Berg, Sander Holthuisen, Marolijn Christianen, Johan van de Koppel
Royal Netherlands Institute for Sea Research

All over the world, coastal ecosystem engineers such as bivalves, sea grass or corals, have declined, influencing entire ecosystems. In the last decades, many projects have been set up to restore these ecosystem engineers. However, the restoration of mussel bed showed limited success. Mussels are ecosystem engineers building reefs that provide refuge for many species, and filter the water. In the Netherlands, the Waddensleutels project was set up to study intertidal mussel bed restoration. Within this project, we studied the limitation of basic restoration techniques and how they can be improved. Transplantation has been widely used in restoration projects. In intertidal mussel bed restoration, artificial beds are usually built with mussels collected from subtidal beds. However, subtidal mussels were shown not to be able to survive in intertidal areas, limiting the success of mussel bed restoration. Another determining factor for artificial mussel bed persistence is the ability for mussels to aggregate and to form clumps. If artificial mussel beds are set up with a too low density, mussels will not be able to form clumps to face hydrodynamic and predation stress. Our study can help improve the restoration design, but intertidal mussel bed restoration remains an interesting challenge for the future.

4. **The Atlas Natural Capital: Pathways to a more natural and sustainable use of our environment**

Ton de Nijs, Saskia Ras, Ton Breure, Martijn Thijssen, Caroline van de Veerdonk, Philip Crebas, Marjolein Mann
National Institute for Public Health and the Environment

Recently the Atlas Natural Capital has been launched: www.atlasnaturalcapital.nl. The Atlas is the implementation of Action 5 of the EU Biodiversity Strategy in the Netherlands, which was accepted by European Parliament in 2012. Main objectives of the Biodiversity Strategy concern the safeguarding of ecosystems ('no net loss'), promoting the application of ecosystem services, and restore 15% of degraded ecosystems. Our natural capital includes everything of value supplied by nature, such as food and drinking water. It includes also the services that nature provides us of which we are not aware of e.g. production of oxygen by trees, dunes protecting us from flooding, bees that pollinate our crops and soils that capture & purify the water for our agriculture and industries. Our natural capital is currently not properly mapped and valuated. It is the aim to fully map and assess the natural capital of the Netherlands by 2020. By then, its value and benefits should have been defined and should be included in decisions by government, NGO's and businesses. The project aims are the identification and disclosure of relevant information as well as obtaining consensus on the mapping, assessment and valuation of our natural capital and ecosystem services. Currently the Atlas contains more than 200 maps, indicators of all major ecosystems services and natural capital in our living environment.
As stated in the national Implementation Agenda Natural Capital, the Atlas should serve as the primary source of information to the TEEB project, to the system of Natural Capital Accounting, and to spatial planners deciding on spatial developments, road construction, new residential and industrial areas, or water storage areas. The Atlas should also serve managers of nature, water, agricultural and urban areas giving better insights how to use our natural environment in a more natural and sustainable way, showing best-practices and new pathways to optimize the various ecosystem services in a region.

5. **Woody debris increases and stabilizes macrofauna abundances in river construction works**

Ellen Weerman, M. Moeleker, R.E. Lapperre, M.A.J. Kerkhoff, B. Brugmans
HAS University of Applied Sciences

River restoration and rehabilitation has become a priority task for authorities to comply the European Water Framework Directive. In the past, most rivers have been normalized resulting in an uniform flow rate which is unfavorable for macrofauna survival. One of the methods to increase water flow velocity in a semi-natural way is to fix woody debris into the river bed. Woody debris will lead to increased habitat heterogeneity by causing variable water flow velocity. Theory predicts that increased habitat heterogeneity increases and stabilizes associated macrofauna diversity. In the "Snelle Loop", a river in the South of the Netherlands, a dam was removed and replaced with 10 patches of woody debris to increase water level and slow down flow rate over a course 1,2 kilometer. Hydrodynamics, water quality and macrofauna communities were measured twice a year for almost three years. The removal of the dam caused a water level decrease of 50 cm, the introduction of 10 woody debris constructions resulted in an increased water level between 34 and 51 centimeter depending on the abundance of organic matter in the stream. However, the specific effect of each woody debris construction differs between 1 and 8 cm water level. The input of woody debris resulted in increased habitat heterogeneity and increased macrofauna diversity. Surprisingly, already within a year after appliance of the woody debris, macrofauna species indicative for healthy streams were already sampled. During the following sampling periods the same and even more species specific for healthy river ecosystems were found. For example, the red list species *Goera pilosa* was found half a year after the dam was replaced by woody debris. Macrofauna diversity seems to be higher near patches with grind as substrate and high habitat heterogeneity. Results from this study show that woody debris can be a successful natural replacement of dams and can increase habitat heterogeneity and stabilizes macrofauna abundances.

6. **Long-range connectivity of coastal ecosystems through wave-dissipation depends on tidal range**

Jim van Belzen, Sil Nieuwhof, Martin Skov, Andrew Davies, Andrew Blight, Steve Hawkins, Barbara Zannuthig, Marieke van Katwijk, Johan van de Koppel, Peter Herman, Tjeerd Bouma
Royal Netherlands Institute for Sea Research

Recent studies call for ecosystem-based approaches to create sustainable coastal defences. Shallow-water ecosystems, like tidal marshes, seagrasses and biogenic reefs, can dissipate waves and storm surges. Nevertheless, we currently lack insights under which environmental settings these habitats will be most valuable and stable for sustainable integration into coastal defence schemes. We used wave-dissipation measurements in the field together with tools from connectivity theory to understand when up-shore facilitation between different coastal ecosystems occurs and how this depends on tidal settings and different landscapes. In small tidal ranges, ecosystems reside within each other's wake zone creating an up-shore facilitative cascade across the tidal gradient. Wave-dissipation is maximal in these connected systems. However, connectivity can get lost at greater tidal ranges, jeopardizing ecosystem stability and, ultimately, coastal safety. Our study is a nice example of how theoretical concepts can be applied to aid the conservation and management of coastal systems.

Poster titles and numbers

Please note that during the poster session on Tuesday all **odd-numbered** posters will be attended /discussed and on the poster session of Wednesday all **even-numbered** posters will be attended /discussed.

#	Name	Poster title
1	Walter Andriuzzi	Can deep-burrowing earthworms counteract the effects of extreme rain events on soil and plants?
2	Qiaoli Ayi	A new method for studying the role of compartmented stem pith cavity in internal aeration and growth performance of partially submerged plants
3	Lisette Bakker	Predicting drought resilience of grassland plant communities through belowground functional traits
4	Janna Barel	Understanding specific plant-soil feedback: Comparing agro-ecosystem & natural grassland
5	Sarah Bedolfe	Effects of invasive parasitic copepod (*Mytilicola orientalis*) on native blue mussel (*Mytilus edulis*)
6	Rob van Bemmelen	Individual consistency in migration trajectories of Long-tailed Skuas
7	Matty Berg	Adaptive capacity of salt marshes
8	Karen Bisschop	The spatial and community-context of ecological specialisation
9	Roeland Bom	Crab plovers are scared of their own prey
10	Annieke Borst	Food or furniture: a Spanish moss study
11	Luc De Bruyn	Effects of Agri-environment schemes on farmland birds in Flanders
12	Pella Brinkman	Centre for Soil Ecology (CSE)
13	Hui Cheng	The effect of *Arenicola marin* pumping on the material exchange in permeable sediments
14	Lucille Chrétien	Challenging the balance between defence and reproduction: Phytohormonal interplay and ecological consequences for flowers under multiple attack
15	Loreta Cornacchia	Trapping capacity of submerged vegetation patches and influence on propagule dispersal
16	Tisja Daggers	Measuring primary production of benthic microalgae in the field: challenges and opportunities
17	Sigrid Dassen	Soil bacterial and fungal community composition along a plant species richness gradient
18	Hélène De Paoli	Can we improve mussel bed restoration?
19	Ellen Decaestecker	Adaptation to toxic cyanobacteria through the symbiotic microbiota in the waterflea *Daphnia magna*

#	Name	Poster title
20	Leen Depauw	Pastforward: Development trajectories of temperate forest plant communities under global change: combining hindsight and forecasting
21	Marlous Derksen-Hooijberg	Mutualistic (?) interactions in a *Spartina alterniflora* saltmarsh
22	Hendrik van Dijk	Musselbeds in the Wadden Sea, development during last decades
23	Mathias Dillen	The interplay of environmental drought stress and neighbourhood tree diversity effects
24	Francisco Dini-Andreote	Disentangling mechanisms that mediate the balance between stochastic and deterministic processes in microbial primary succession
25	Gilian van Duijvendijk	How Lyme disease bacteria manipulate their reservoir host
26	Fabiènne Doveren	Biodiversity by design: Can the Sand Motor resemble its natural analogue?
27	Eva van den Elzen	Sphagnum vs. its microbiome: who benefits?
28	Helen Esser	Wildlife diversity loss and the emergence of tick-borne diseases in Panama
29	Minghui Fei	Ecological costs and benefits of a gregarious lifestyle across three trophic levels
30	Oscar Franken	Thermal mismatches in a soil food web, investigated by artificial heat waves in a natural ecosystem
31	Thijs Frenken	Impact of global warming on the fungal infection of a phytoplankton spring bloom
32	Yuki Fujita	Plant feedbacks on soil water retention: effects of succession and grazing in dune grasslands
33	Stefan Geisen	Soil protists: distribution and ecological roles
34	Jan van Gils	Predator intake rates do not necessarily increase with prey density: a field study on red knot foraging distributions
35	Stijn van Gils	How multiple ecosystems services influence wheat yield: interplay among soil organic matter, water availability, fertilizer and a fungal pest
36	Annelies van Ginkel	Landscape of fear in closed-canopy forests
37	Dorit Gross	What drives forest changes in African protected areas?
38	Nienke Hartemink	Towards a resource-based habitat approach for geospatial modelling of vector-borne disease risks
39	Amber Heijboer	The soil microbial community: a key player in nutrient management
40	Lia Hemerik	Comparison of the effect of predicted climate change on two agricultural pest-parasitoid systems
41	Kasper Hendriks	On the origin of species assemblages – community assembly of microsnail communities on Borneo
42	Alinda ten Hove	Hedwige polder: from mudflat to reed field?

#	Name	Poster title
43	Ruth Howison	Ground Breakers
44	Wendy Jesse	(Un)successful traits - Identification of morphological traits indicative of colonization success and extinction risk in Anolis lizards
45	Inger de Jonge	Forest-Grassland Transitions in Subtropical South America: Tree recruitment patterns at the ecotone between riverine forests and grasslands
46	Atiyeh Kashaninia	Effect of phytohormones on trichomes production in *Solanum lycopersicum* , *Solanum galapagense* and the hybrid line
47	Yodit Kebede	Quantifying arthropod abundance and diversity to assess the potential for natural control of maize stemborers in Hawassa, Ethiopia
48	Joost Keuskamp	Cyclic succession of mangrove trees driven by decomposition
49	Ineke Knot	Leaf me alone: The influence of habitat on predation and parasitic risk in Túngara frogs
50	Xiangzhen Kong	Modelling the regime shifts in a large shallow Chinese lake during the last 60 years
51	Viola Kurm	A role for rare soil bacteria in ecosystem functions
52	Isabella Kratzer	Give plants a chance - the conditionality of Windows of Opportunity in seedling establishment
53	Thomas Lameris	Possible ecological trap in post-Soviet land-use change for an Eurasian steppe bird
54	Jenny Lazebnik	The stressed-out potato: How do potato deal with biotic stress?
55	Jeroen van Leeuwen	Soil ecosystem development in a glacial chronosequence in Iceland
56	Kimberley Lemmen	Impact of Food Quality on the Functional Response of the Rotifer *Brachionus calyciflorus*
57	Sofia Licci	Effects on flow and sediment composition of two macrophyte species with contrasting morphologies
58	Marloes van Loon	Plant-plant interactions mediate the plastic and genotypic response of *Plantago asiatica* to CO2: an experiment with plant populations from naturally high CO2 areas
59	Emily van Loon-van Egmond	Competitive interactions alter carbon and nitrogen uptake within a simple macroinvertebrate community of an intertidal beach: a stable isotope experiment
60	Dani Lucas-Barbosa	Caught between parasitoids and predators - survival of a specialist herbivore on leaves and flowers of mustard plants
61	Nicky Lustenhouwer	Phenotypic variation between core and edge populations of a range expanding plant species
62	Marta Manrubia Freixa	Litter decomposition and home-field advantage during plant range shifts
63	Annelein Meisner	Microbial growth upon rewetting: effects of long-term drought legacies
64	Simeon Moons	Sand, water, waves and iron worms

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65	Elly Morriën	Soil biodiversity and nutrient cycling in a chronosequence of abandoned agricultural fields
66	Rascha Nuijten	Contaminants in the Arctic: food chain accumulation and effects
67	Astra Ooms	Soil community assembly explained by variation in species functional traits
68	Natalie Oram	Root turnover in grassland biodiversity experiments: root traits and interactions with soil biota
69	Thomas Oudman	The effect of diet choice behaviour on prey populations
70	Astrid Potiek	Wind turbines: a threat to bird populations?
71	André van Proosdij	Pushing the boundaries of Species Distribution Modelling
72	Marinka van Puijenbroek	Relating incipient dune development to sand transport and storm frequency
73	Casper Quist	Micro- and macro-distribution of nematode taxa in arable and natural areas
74	Quint Rusman	How different kinds of herbivory affect flower associated organisms
75	Marjolein de Rijk	Non-host feeding guild affects host-foraging efficiency of a parasitic wasp
76	Kenneth Rijsdijk / Harry Seijmonsbergen	Geodiversity as predictor for biodiversity
77	Ineke Roeling	Plant diversity of Dutch grasslands: the problem of eutrophication
78	Laura Seelen	Determining the ecosystem services of deep man-made lakes
79	Tatiana A. Semenova	Ascomycete fungal communities respond to long-term climate manipulations in arctic Alaska
80	Bram Sercu	The TREEWEB project: scaling up functional biodiversity research
81	Janneke Sindram	Shedding light on wood mouse (*Apodemus sylvaticus*) behaviour: a strictly nocturnal rodent's response to increasing illuminance intensities
82	Marelle van der Snoek	Plant-Fish project
83	Annemarieke Spitzen	Amphibian chytridiomycosis: a bicephalic monster
84	Yingying Tang	Phosphorus extraction and recycling on flooded, former agricultural lands: role of soil characteristics
85	Jelle Treep	Seed dispersal by wind: Do plants select favourable weather conditions for takeoff?
86	Ana Rita Pessoa de Figueiredo Vasques	How do pine structure and fire regime determine shifts in plant community composition?
87	Ciska Veen	East West Home's Best - when do specialized decomposers accelerate decomposition?

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88	Rik Veldhuis	Plant stress-tolerance traits predict salt marsh vegetation patterning
89	Mandy Velthuis	The impact of global warming on phytoplankton stoichiometry and community dynamics
90	Peter Vermeulen	Relative yields, De Wit and complementarity: the sampling effect from a competition perspective
91	Wilco Verberk	Hypoxia and warming interactively impact survival and abundance of stream mayflies
92	Klaas Vrieling	A flexible SNP genotyping line
93	Heng Wang	Influencing factors on lateral retreat of saltmarsh seaward boundaries
94	Shuhang Wang	Antibiosis resistance to cabbage root fly, and the larvae behaviour
95	Simone Weidner	Dilution of microbial soil community selects for K-strategists (serial dilution approach)
96	Ellen Weerman	Food preferences of two invasive crayfish species of the Netherlands
97	Rutger Wilschut	Belowground interactions of range-expanding plant species, root-feeding nematodes and their antagonists
98	Yan Yan	Soil's power to shape bacterial communities during incubation of diverse inoculate
99	Naili Zhang	Fine root litter diversity and decomposition
100	Peiyu Zhang	Effects of climate warming on *Potamogeton crispus* growth and tissue stoichiometry in the growing season
101	Weiwei Zhao	Disentangling the drivers of coarse woody debris behaviour and gas efflux during fire
102	Bas Oteman	Salt marsh development observed from space