NAEM 2013

Netherlands Annual Ecology Meeting

5 & 6 February 2013

Congrescentrum De Werelt, Lunteren

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

Programme

Tuesday 5 February

	Main Entrance Hall			
8:30	Registration and coffee in the Lounge and setting up posters			
	Europe Hall			
10:15	**Word of Welcome** • Hans de Kroon (Chair of the Meeting) • Jaap van der Meer (Chair organising committee, Royal Netherlands Institute for Sea Research)			
	Plenary 1: Making a move in movement ecology			
10:30	1. **Do Lévy flights, walks and waits identify a common ecology of movement?** (David Sims, Marine Biological Association of the UK, University of Southampton, UK.)			
11.15	2. **Darwin or Einstein, who sets the scene for movement ecology?** (Johan van de Koppel, Royal Netherlands Institute for Sea Research)			
12:00	**Lunch in the restaurant**			
	Europe Hall	**America Hall**	**Asia Hall**	**Africa Hall**
13:30	**Parallel 1a: Spatial Ecology**	**Parallel 1b: Trait-based approach in ecological research**	**Parallel 1c: The Ecology of Behavioural Plasticity**	**Parallel 1d: Ecology in Practice**
	Conveners: 1. Monique de Jager (Royal Netherlands Institute for Sea Research) 2. Merel Soons (Utrecht University)	*Conveners*: 1. Nadia Soudzilovskaia (VU-Amsterdam)	*Conveners*: 1. Marc Naguib (Wageningen University) 2. Christiaan Both (University of Groningen)	*Conveners*: 1. Margje Voeten (HAS Den Bosch) 2. Wolf Mooij (Netherlands Institute of Ecology)
13:30	Combining Levy walks with patch exploitation rules, an exploration of optimal exploration-exploitation strategies. (Geerten Hengeveld, Netherlands Institute of Ecology)	Tricks of the traits: the value of functional traits for understanding community structure and composition. (Matty Berg, VU-Amsterdam)	Personality and plasticity: consequences and underlying causes of behavioural consistency. (Kees van Oers, Netherlands Institute of Ecology)	Improving ecosystem services by experimental ecological research: C sequestration, natural capping and peatland restoration on the former waste dump Volgermeerpolder. (Sarah Faye Harpenslager, Radboud University Nijmegen)
13:50	Reconstructing the spatio-temporal distribution of shorebirds in intertidal areas: a case study of the Oystercatcher. (Adriaan Dokter, University of Amsterdam)	Integrating species traits to transform descriptive community ecology into a predictive science. (Wilco Verberk, Radboud University Nijmegen)	Tracking the social lives of great tits: behavioural consistency in a social context. (Lysanne Snijders, Netherlands Institute of Ecology / Wageningen University)	Functional characteristics determine growth responses of tree species to logging and silvicultural treatments. (Marielos Peña Claros, Wageningen University)
14:10	Disturbing signs: Spatial indicators of tipping points in salt-marsh ecosystems. (Jim van Belzen, Royal Netherlands Institute for Sea Research)	Changes in traits of alpine plant leaves in response to fertilization (V. Onipchenko & A. Akhmetzhanova, Moscow State University)	Plasticity versus personality: how plasticity in digestive processing capacity and personality of red knots interact. (Allert Bijleveld, Royal Netherlands Institute for Sea Research)	Exploiting knowledge on habitats used by arthropods to predict value of ecosystem services in agro-landscapes. (Felix Bianchi, Wageningen University)
14:30	Short Break			

	Parallel Session 1 Continued			
14:40	Stability of oceanic island biomes from a paleo-ecological perspective. (Erik de Boer, University of Amsterdam)	Does drought-tolerance explain high liana abundance in dry forests? (Masha van der Sande, Wageningen University)	How do family conflicts affect behavioural plasticity? (Camilla Hinde, Wageningen University)	Healthy plant protection. (Kirsten Leiss, Leiden University)
15:00	Vegetation patchiness induced by grazing – The role of grazer species, density and underlying abiotic patterns. (Stefanie Nolte, University of Groningen)	Impacts of climate-driven trait variation on performance of a dynamic global vegetation model. (Lieneke Verheijen, VU-Amsterdam)	The cost of reproduction in a social context. (Joost Tinbergen, University of Groningen)	*Alexandrium* in the polder: fighting off a harmful algal bloom in Zeeland with hydrogen peroxide. (Amanda Burson, University of Amsterdam)
15:20	Chemical variation in *Jacobaea vulgaris* can be influenced by succession stage of vegetation and season. (Sabrina Carvalho, Netherlands Institute of Ecology)	Response of community functional properties to land use intensification in tropical ecosystems. (Geovana Carreño-Rocabado, Wageningen University)	Modelling adaptive flight orientation among avian migrants. (James McLaren, University of Amsterdam)	When does fishing lead to more fish? Community consequences of bottom trawl fisheries in demersal food webs. (Daniel van Denderen, IMARES)
15:40	**Coffee and tea in the lounge**			
	Europe Hall	**America Hall**	**Asia Hall**	**Africa Hall**
16:00	**Parallel 2a: Evolutionary Ecology: Genetics of Adaptation to Environmental Shift & Species interactions**	**Parallel 2b: Exotic species: An addition or a plague?**	**Parallel 2c: Coastal Ecology**	**Parallel 2d: Ecology of Urbanisation**
	Conveners: 1. Sylvia Gerritsma (University of Groningen) 2. Wen-Juan Ma (University of Groningen)	*Conveners*: 1. Bart Grutters (Netherlands Institute of Ecology) 2. Ivo Roessink (Wageningen University) 3. Anne Immers (Netherlands Institute of Ecology)	*Conveners*: 1. Tjisse van der Heide (Radboud University Nijmegen / University of Groningen) 2. Marjolijn Christianen (University of Groningen)	*Conveners*: 1. Kamiel Spoelstra (Netherlands Institute of Ecology) 2. Roy van Grunsven (Wageningen University)
16:00	Genetics of adaptation: A genomic approach to deciphering adaptive behaviour in a parasitoid wasp. (Bart Pannebakker, Wageningen University)	Exotic species: benefits or plague. (Ivo Roessink, Wageningen University)	Ecosystem engineers as the foundation of coastal ecosystems. (Tjisse van der Heide, Radboud University Nijmegen / University of Groningen)	Ecology in an urbanized world. (Roy van Grunsven, Wageningen University)
16:20	Natural selection for a mutant *Nicotianamine Synthase 1* allele in a heavy metal adapted *Noccaea caerulescens* population. (Mark Aarts, Wageningen University)	Do exotic plants in the Netherlands affect plant diversity? (Thomas van Hengstum, University of Amsterdam)	Modelling Biota-Sediment Interactions in Estuarine Environments. (Francesco Cozzoli, Royal Netherlands Institute for Sea Research)	Only sex with the lights off? Moth reproduction in illuminated nights. (Koert van Geffen, Wageningen University)
16:40	Mechanisms of maintaining a hyperimmune state in populations of *Streptococcus Pneumoniae.* (Monica Abrudan, Leiden University)	Patterns of impact of three invasive plant species on freshwater ecosystems. (Iris Stiers, Vrije Universiteit Brussel)	Importance Of Spatial Patterns In The Persistence Of New-Settled Mussel Beds In The Wadden Sea. (Hélène de Paoli, Royal Netherlands Institute for Sea Research)	Nocturnal illumination affecting birds' activity patterns. (Maaike de Jong, Netherlands Institute of Ecology)
17:00	Short Break			

Parallel Session 2 Continued				
17:10	Footprints of selection in wild populations of *Bicyclus anynana* along a latitudinal cline. (Bas Zwaan, Wageningen University)	Impact and spread of alien macro-invertebrates in surface waters in Flanders. (Pieter Boets, Ghent University)	A three-stage symbiosis forms the foundation of seagrass ecosystems. (Laura Govers, Radboud University Nijmegen)	"Verlust der Nacht" – an interdisciplinary research project addressing the effects of artificial light at night. (Stephanie Holzhauer, Leibniz Institute of Freshwater Ecology and Inland Fisheries)
17:30	Adaptation and Heterogeneity of *Escherichia coli* MC1000 Growing in Complex Environments. (Pilar Puentes, University of Groningen)	Assessing and comparing invasive dreissenid mussels. (Michiel Verhofstad, Netherlands Institute of Ecology / Radboud University Nijmegen)	Green Turtles That 'Dig' For Dinner And Seagrass Collapse. (Marjolijn Christianen, Radboud University Nijmegen)	Emergence of Household pests in The Netherlands. (Bruce Schoelitsz, Kenniscentrum Dierplagen / Wageningen University)
17:50	Quantitative genetics, selection and photosynthesis in *Arabidopsis thaliana.* (Pádraic Flood, Wageningen University)	Negative impact of invasive Ponto-Caspian gobiid fish species on the densities of the native Bullhead (*Cottus perifretum*) in the River Meuse: its cause and mechanism. (Martijn Dorenbosch, Radboud University Nijmegen)	Emergent community effects and life-history characteristics of a predatory fish. (Floor Soudijn, University of Amsterdam)	In sex and the city: urbanization as driver of emerging infectious diseases. (Sander Koenraadt, Wageningen University)
18:10	Drinks in the Lounge and from **18:30** onwards dinner in the restaurant			
19:30	**Poster sessions 1 (Odd-numbered posters are presented and discussed) / Coffee**			
	Europe Hall			
21:00	**Evening Programme:** The Pursuit of Complexity. The utility of biodiversity from an evolutionary perspective (Gerard Jagers op Akkerhuis, Wageningen-UR)			

Wednesday 6 February

7:30	Breakfast in the restaurant			
8:00	Registration for those coming on Day 2 only			
	Europe Hall	**America Hall**	**Asia Hall**	**Africa Hall**
8:30	**Parallel 3a: Trophic Interactions**	**Parallel 3b: Adaptation to climate change across time and space**	**Parallel 3c: Ecology meets physiology**	**Parallel 3d: Disease ecology and Ecological Immunology**
	Conveners: 1. Ciska Veen (Netherlands Institute of Ecology / Swedish Agricultural University) 2. Tess van de Voorde (Wageningen University)	*Conveners*: 1. Tom Reed (Netherlands Institute of Ecology) 2. Marleen Cobben (Wageningen UR)	*Conveners*: 1. Wilco Verberk (Radboud University Nijmegen) 2. Ronald Pierik (Utrecht University)	*Conveners*: 1. Jacintha van Dijk (Netherlands Institute of Ecology) 2. Nienke Hartemink (Utrecht University)
8:30	Linking plant-soil feedback and belowground-aboveground interactions. (Martijn Bezemer, Netherlands Institute of Ecology)	Changing phenology when phenotypic plasticity does not suffice: evidence for evolution in action? (Christiaan Both, University of Groningen)	Mixotrophs in the food web: Linking physiology to population dynamics. (Susanne Wilken, Netherlands Institute of Ecology / University of Amsterdam)	Habitat connectivity and other landscape factors in the context of vector-borne diseases. (Nienke Hartemink, Utrecht University)
8:50	Effects of intraspecific variation in plant defense on aboveground and belowground herbivores of ribwort plantain, *Plantago lanceolata.* (Jinghua Huang, Netherlands Institute of Ecology)	Evolutionary response of egg hatching date of an herbivorous insect under climate change. (Lucia Salis, Netherlands Institute of Ecology / University of Groningen)	Natural variation in encapsulation ability and hemocyte load in *Drosophila melanogaster.* (Sylvia Gerritsma, University of Groningen)	Timing and effect of influenza A virus outbreaks in breeding colonies of Black-headed gulls. Josanne Verhagen, Erasmus Medical Centre Rotterdam)
9:10	Seasonal phenology of interactions involving multivoltine herbivores and their endoparasitoid wasp. (Minghui Fei, Netherlands Institute of Ecology)	Space is not time! A theoretical model of dietary restriction responses in temporally and spatially varying environments. (Joost van den Heuvel, Leiden University)	Physiological effects of *Varroa destructor* on honey bees. (Coby van Dooremalen, Wageningen UR)	Walking with insects: how baculoviruses manipulate caterpillar behaviour. (Stineke van Houte, Wageningen University)
9:30	Short Break			
9:40	Trophic interactions reduce terrestrialisation and plant diversity in riparian vegetation. (Liesbeth Bakker, Netherlands Institute of Ecology)	Climate change and weather extremes: are there reasons to be worried? (Agnieszka Malinowska, Wageningen University)	Canopy light cues affect emission of constitutive and methyl jasmonate-induced volatile organic compounds in *Arabidopsis thaliana.* (Wouter Kegge, Utrecht University)	Effects of the invasive Pacific Oyster on native pathogen-host systems in the Wadden Sea. (Anoek Goedknegt, Royal Netherlands Institute for Sea Research)
10:00	Belowground overyielding in a long-term biodiversity experiment. (Janneke Ravenek, Radboud University Nijmegen)	Adapting forest management to climate change – impacts of (anticipated) climate change on forest dynamics. (Geerten Hengeveld, Wageningen UR)	Self/non-self discrimination in *Potentilla reptans*: interactions between physiological and physical distance? (Bin Chen, Utrecht University)	How does a free-living bird stay healthy year-round? Trade-offs and disease risk result in complex patterns of immune function. (Arne Hegemann, University of Groningen)
10:20	Overyielding in plant species mixtures: a key role for belowground trophic interactions? (Gerlinde De Deyn, Wageningen University)	Microevolution of trees and climate change. A simulation study bridging ecophysiology and quantitative genetics. (Koen Kramer, Wageningen UR)	Effects of drought on species composition and distribution of tropical forests; the underlying mechanisms. (Lourens Poorter, Wageningen University)	Describe microbial communities associated with eggs to comprehend avian immune system. (Stéphanie Grizard, University of Groningen)
10:40	Coffee and tea in the lounge			

	Europe Hall			
	Plenary 2: Microbial ecosystem drivers in a changing world			
11:00	1. **Complex microbial communities in an era of global environmental questions** (Mary Firestone, University of California, Berkeley)			
11.45	2. **Changing times for us all – from individual bacteria to global patterns** (George Kowalchuk, Utrecht University)			
12:30	**Lunch in the restaurant**			
13:30	**Poster Session 2 (Even-numbered posters are presented and discussed) / Coffee**			
	Europe Hall	**America Hall**	**Asia Hall**	**Africa Hall**
15:00	**Parallel 4a: Microbial ecology - From species richness to functional biodiversity**	**Parallel 4b: Integration of population genetics, dynamics and social structure**	**Parallel 4c: Biodiversity and conservation in a spatial context**	**Parallel 4d: Recent advances in paleo-ecology; relations between vegetation and environment**
	Conveners: 1. Anne Daebeler (Netherlands Institute of Ecology) 2. Sascha Krause (Netherlands Institute of Ecology) 3. Bjorn Robroek (Utrecht University)	*Conveners*: 1. Arjen de Groot (Wageningen UR) 2. Eelke Jongejans (Radboud University Nijmegen)	*Conveners*: 1. Kees Musters (Leiden University) 2. Marije Kuiper (Wageningen University)	*Conveners*: 1. Martin Wassen (Utrecht University) 2. Stefan Dekker (Utrecht University) 3. Friederike Wagner-Cremer (Utrecht University)
15:00	Microbial transformations of nitrogen, sulfur and iron dictate vegetation composition in wetlands: an overview. (Leon Lamers, Radboud University Nijmegen)	Non-invasive techniques reveal spatiotemporal variation in social, demographic and genetic structure. (Arjen de Groot, Wageningen UR)	Biodiversity and conservation in a spatial context. (Kees Musters, Leiden University)	Optimization of stomatal densities and vein densities in leafs on evolutionary and contemporary time scales. (Martin Wassen, Utrecht University)
15:20	The Role of Diversity and Traits in Methane Cycling in Wetlands: a model for conceptualizing microbial life strategies. (Paul Bodelier, Netherlands Institute of Ecology)	Population dynamics of Arabidopsis *lyrata* ssp. *petraea* across its range explained by environmental variation. (Philippine Vergeer, Radboud University Nijmegen)	Biodiversity sources or diaspore sinks: stream restoration in a fragmented landscape. (Rob Fraaije, Utrecht University)	Paleo-ecology meets ecology: high-resolution pollen records show rapid climate-forced and system-driven change. (Henry Hooghiemstra, University of Amsterdam)
15:40	Temporal dynamics of archaeal ammonia oxidizers in agricultural soil in response to different environmental parameters. (Michele Pereira e Silva, University of Groningen)	Partitioning genetic variation into independent spatial and ecological components. (Patrick Meirmans, University of Amsterdam)	Spatiotemporal interactions between agri-environment schemes and nature reserves (William van Dijk, Wageningen University)	Spring season changes reflected in modern and fossil leaf cuticles. (Rike Wagner-Cremer, Utrecht University)
16:00	Break			
16:10	First kingdom-wide fungal diversity assessment in the Andean cloud forests reveals strong community structuring among forest types along an altitudinal gradient. (József Geml, Naturalis Leiden)	Effect of habitat suitability and connectivity on adaptation, inbreeding and metapopulation viability. (Peter van Tienderen / Gerard Oostermeijer, University of Amsterdam)	Core areas for meadow birds require clear choices. (Dick Melman, Wageningen UR)	Using tree rings and isotopes to understand responses of the Amazon basin to climate change: recent advances and pitfalls. (Roel Brienen, University of Leeds)
16:30	Snow cover manipulation effects on microbial community structure and soil chemistry in a mountain bog. (Amber Heijboer, Wageningen University)	Surviving in a cosexual world: dioecy as a reproductive strategy (Marjolein Bruijning, Radboud University Nijmegen)	An experiment to test a novel economic agri-environment scheme. (Almut Schlaich, Montagu's Harrier Foundation / University of Groningen)	

16:50	The stability and variability of intestinal microbial diversity across healthy human population. (Leo Lahti, University of Helsinki / Wageningen University)	Colourful mites: the effects of environmental noise on the population dynamics of selectively harvested populations (Hedwig Ens, Imperial College London)	Nature Conservation meets Video Game Technology: a real-time 3D landscape reconstruction of pristine Mauritius. (Bodo Schütze, University of Amsterdam)	
	Europe Hall			
17:20	• **Awards ceremony** (Hans de Kroon) o Best PhD research paper Award (Member of the Evaluation Committee) o Best Poster Award (Roland Bobbink, Chair NECOV) • **Final words** (Louise Vet)			
	Lounge			
18:00	**Fare-well 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

Making a move in movement ecology

Recent advances in tracking technology have provided thrilling insights into the complexity of animal movement. In this session, by combining data from large-scale movement of predatory fish and seabirds in the ocean to small-scale movement of mussels in a bathtub, we show that complex movement is found even under the simplest conditions, but that in complex ecosystems, movement is sometimes remarkably simple.

1. **Do Lévy flights, walks and waits identify a common ecology of movement?**
   (David Sims, Marine Biological Association, UK / University of Southampton, UK)

Animals must often make behavioural decisions based on incomplete information about their environment leading to degrees of randomness in actions. Theoretically, animals can achieve efficiency gains by adopting scale-invariant patterns of random activities. An open question in ecology, therefore, is whether animals have adapted simple stochastic patterns of spontaneous behaviour based on scale-invariant organisation that perform well in naturally complex environments. Here, I show that a 'bursty' pattern of actions characterised by scale-invariance appears common among diverse taxa, from cephalopods to fish and seabirds, and I explore the idea that it is an intrinsic 'rule of thumb' being shaped by evolving behavioural strategies.

2. **Darwin or Einstein, who sets the scene for movement ecology?**
   (Johan van de Koppel, Royal Netherlands Institute for Sea Research)

For decades, Brownian motion has been the default model for ecological movement and dispersal. However, the use of Brownian motion as a description of large-scale animal dispersal has been challenged by empirical studies, which reveal complex movement patterns even in simple environments. Based on combined experimental and theoretical work, I show that the movement of mussels is shaped by the struggle between adaptive movement strategies and ecological encounters, following Einstein's theory for Brownian motion. Our work on mussel movement highlights the need for a new look at ecological dispersal.

Plenary Session 2

Microbial ecosystem drivers in a changing world

Microbes dominate our planet. They are the most abundant and diverse organisms on Earth, and their activities drive the functioning of virtually all ecosystems, including soils. However, due to human influences, the communities responsible for microbial ecosystem services are coming under increased pressure. Numerous advances in microbial ecology are now allowing us to shed light into the black box of soil-borne microbial communities, providing us the opportunity to examine the impacts of environmental changes on these microbial ecosystem motors. This session will highlight a number of recent advances in our understanding of how land use and climate change influence soil-borne microbial communities and the consequences of these changes on ecosystem dynamics and feedbacks to climate.

1. **Complex microbial communities in an era of global environmental questions**
   (Mary Firestone, University of California, Berkeley)

Microorganisms and the communities they comprise are the primary catalysts of most major biogeochemical cycles. Molecular tools now enable microbial ecologists to begin to untangle the taxonomic, phylogenetic, and functional characteristics of what have been described as the most complex and heterogeneous communities on earth, that is soil microbial communities. While promises of revolutionary understanding have been made for data resulting from deep molecular analysis of terrestrial microbial communities, there generally remains a disconnection between molecular community characterization and the questions concerning terrestrial response to changing environment that are driving much terrestrial ecology. What information and understanding of current ecosystem characteristics, environmental history and biogeochemistry, and potential for future response can be found in analyses of soil microbial communities? Two sets of data will be discussed. One set uses molecular characterization of the functional potentials of indigenous microbial communities mediating nitrogen transformations in a boreal ecosystem as the basis for discussion of molecular indices of functional potentials. The second series of experiments assesses the response of indigenous soil communities to desiccation and rewetting as an example of microbial community resistance, and resilience to cyclical changes in the soil environment. The talk will address whether molecular analysis of complex microbial communities can provide information about process potential, environmental and process history, adaptive “anticipation” of repeating change, and potential response to new environments.

2. **Changing times for us all – from individual bacteria to global patterns**
   (George Kowalchuk, Utrecht University)

Our planet is changing rapidly. For the vast majority of Earth’s history, climate has been driven principally by microorganisms and plant-microbe interactions. As we seek understanding of human-induced climate change and potential mitigation strategies, we unfortunately lack basic knowledge of how climatic changes will impact the microbial drivers of ecosystem functioning. I will present a series of studies that examine how soil-borne microbial communities, plant-microbe interactions and microbial geochemical cycling are impacted by climate changes such as elevated CO2 levels and rising temperatures. These studies couple field and laboratory experiments with the evolving molecular and ecogenomics toolbox. I further highlight the need to examine microbial responses at appropriate scales, whether from the perspective of individual bacteria or microbial impacts at large temporal and spatial scales.

Session 1

1a: Spatial Ecology

Conveners: Monique de Jager (Royal Netherlands Institute for Sea Research)
Merel Soons (Utrecht University)

1. Combining Levy walks with patch exploitation rules, an exploration of optimal exploration-exploitation strategies

Geerten M. Hengeveld, Andrea Koelzsch, Johan van de Koppel, Marc Naguib & Bart A. Nolet
Netherlands Institute of Ecology

Animal movement paths are characterised by alternations between clusters of local moves and long-distance movements. Levy walks have been used to describe these movement paths and interpret them using a single parameter. However, this model does not take into account the specific behaviour in exploiting patches. By combining a patch exploitation model with an exploration model we show that the efficiency of the Levy walk in exploration is robust to specific exploitation strategies. With optimal exploitation, the Levy walk is equally efficient as the ballistic search. With changing travel time between patches due to different exploration strategies, the optimal exploitation does not shift; rather the range of optimal exploitation strategies broadens. These results show that the optimal solutions derived analytically for either exploration or exploitation are among the optimal solutions, but not the only optimal solutions to combined exploration and exploitation task animals face.

2. Reconstructing the spatio-temporal distribution of shorebirds in intertidal areas: a case study of the Oystercatcher

Adriaan M. Dokter, Martin J. Baptist, Willem Bouten, Bruno J. Ens, Cornelis Rappoldt & Emiel van Loon
University of Amsterdam

Knowing the spatio-temporal distribution of foraging shorebirds in the Wadden Sea is of basic relevance to policy for managing this protected nature reserve and World Heritage Site. Since spatial monitoring of shorebirds in the entire foraging area throughout the tidal cycle is practically impossible, we need to resort to reconstructions of bird distributions based on limited spatio-temporal monitoring data and quantitative modelling.

Generalised functional response models may be considered the standard null model of shorebird distribution. They have been used to predict the spatial distribution of birds given their distribution of food, under the assumptions that birds attempt to maximize intake rate as a short-term fitness objective and behave as ideal and free predators. Remarkably few quantitative assessments of the degree of applicability of these models to free-living shorebirds exist for real intertidal systems. An important aspect preventing quantitative comparisons with model predictions has been the lack of observational data that covers the relevant temporal cycles (tidal, diurnal, seasonal) affecting spatial distribution and food availability.

Using full-season continuous camera observations and individual GPS-tagging we quantified how free-living Oystercatchers distribute themselves in relation to the tidal cycle and the spatial distribution of cockle and mussel beds. Additionally, we performed high-resolution benthic surveys in the core foraging areas of focal individuals. The study permits a comparison of observed and predicted spatial distribution and food depletion. A remarkable finding is the considerable difference in the day and night foraging distribution of Oystercatchers, which is not accounted for by conventional functional response models.

3. Disturbing signs: Spatial indicators of tipping points in salt-marsh ecosystems

Jim van Belzen, Johan van de Koppel, Daphne van der Wal, Peter M.J. Herman & Tjeerd J. Bouma
Royal Netherlands Institute for Sea Research

Theory suggests that regime shifts in natural systems can be predicted by monitoring recovery rates, which should decrease when approaching a critical threshold. This phenomenon is called critical slowing down, and is suggested to be a general property of natural systems. Although recent controlled laboratory experiment provided evidence for such responses in living systems, this concept remains largely unchallenged in the complex settings of real ecosystems. Here we reveal that critical slowing down can be detected in the realms of a real intertidal salt-marsh ecosystem. By substituting time for space, we capitalized on natural gradients of inundation stress. Spatial analyses of remotely sensed data of salt-marsh development showed that it is possible to locate the tipping point were the salt-marsh ecosystem ceases to exist, based on direct assessment of critical slowing down (recovery rates), and indirectly through spatial indicators. Our findings are further supported by a manipulative field experiment.

4. Stability of oceanic island biomes from a paleo-ecological perspective

Erik J. de Boer, Henry Hooghiemstra & Marten Scheffer
University of Amsterdam

A new high-resolution pollen record showing ecosystem dynamics in the oceanic island Mauritius shows a paradox in concepts on island stability. In oceanic islands many species have persisted for millions of years. Stable conditions of surrounding ocean waters are thought responsible for environmental and biotic stability. However, since human colonization oceanic islands show records of high vulnerability to ecosystem degradation and introduced exotics.

Here, we meticulously document long-term ecological change under natural conditions. At 560 m elevation montane forest shows stable taxonomic compositions during last glacial (38,000-11,500 yr BP) and mid-Holocene times (7600-2300 yr BP). The last glacial forest is wet, open and non-stratified while mid-Holocene forest is less wet, closed, and well-stratified. At the onset of the Holocene the forest ecosystem crossed an ecological threshold and was suddenly propelled into a 4000-yr long period of instability, shown by four abrupt (< 150 yr) forest transitions showing dramatic species turnover. Of this cascade, we interpret the first transition as climate-driven (extrinsic) and the subsequent ones as reflecting spatial reorganizations of montane forest (intrinsic). Gallery forest, spatially and temporally stabilized by the drainage system, served as a long-lasting reservoir of plant diversity. Observed dynamics in the montane forests and postulated stability in the gallery forests fuel the paradox. While migration of biomes as a response to climate perturbation is hardly feasible in small and low-profile islands, rapid compositional biome changes (complex tipping point?) may constitute a functional and adequate alternative.

5. Vegetation patchiness induced by grazing – The role of grazer species, density and underlying abiotic patterns

Stefanie Nolte, Chris Smit, Peter Esselink & Jan P. Bakker
University of Groningen

Grazing animals create a mosaic of patches with short and tall vegetation. Additionally, the highest heterogeneity of vegetation patterns is found at intermediate grazing densities. Furthermore, the underlying abiotic variation might play a role in pattern formation. However, not much is known about the effect different species of grazers have. We tested whether grazer species, density and the underlying abiotic pattern have an influence on vegetation structure patchiness in an experimental approach. The experiment was setup on a salt marsh in The Netherlands in 2010 including two blocks. To each of these blocks the following treatments were applied: horses (0.5 and 1.0 animal/ha) and cattle (0.5 and 1.0 animal/ha). The area includes higher elevated areas close to the seawall with lower salt stress (high marsh) and lower elevated areas with higher salt stress (low marsh). Six transects of 25 m length were randomly positioned in each treatment with three in the high and three in the low marsh respectively. Along transects the canopy height was measured every 25cm with a Styrofoam drop disk of 25cm diameter and a calibrated stick. Measurements were repeated in May 2011, August 2011 and August 2012. Additionally, the elevation as a proxy for the abiotic conditions was measured at each point using a leveling instrument. By fitting a model to the variogram of each transect we obtained the parameters characterizing the spatial correlation. These parameters were compared to see how the treatments and the underlying abiotic pattern influence vegetation structure patchiness.

6. Chemical variation in *Jacobaea vulgaris* can be influenced by succession stage of vegetation and season

Sabrina Carvalho
Netherlands Institute of Ecology

Knowledge on plant chemistry variation is important to assess spatio-temporal dynamics of plant nutrient and defence allocation in natural conditions. Here we investigated seasonal shifts in primary and secondary chemistry of *Jacobaea vulgaris* and its relation to the stage of secondary succession. We used a chronosequence of abandoned arable fields as space for time substitution and analyzed the chemical content for both leaf and flower organs, as these may differ in chemical defence during plant life history development and environment/evolutionary pressures. The chemical concentration of *J. vulgaris* varied throughout the season and was affected by the vegetation succession stage. Pyrrolizidine alkaloids (PA) tertiary-amines were higher in flowers during early summer and in fields that had been abandoned ten to twenty years ago. PA N-oxide concentrations of both leaf and flowers increased with the progression of the growing season and secondary succession. Chlorophyll a was higher than chlorophyll b in spring and in plants from early succession fields. The differences in PA composition and concentration of leaves and flowers provide some evidence for optimum defence strategy with flowers better defended in early summer. Our results suggest that the contribution of plant metabolites to aboveground defence will vary with successional position as well as season. This suggests differential selection by the biotic environments, leading to optimize defences for the particular interactions, season * succession (abandoned fields). The substitution of space for time provided important insights on the *J. vulgaris* spatial temporal processes related to organ defence and nutritional allocation in semi-natural environments.

1b: Trait-based approach in ecological research

Conveners: Nadia Soudzilovskaia (VU Amsterdam)

1. Tricks of the traits: the value of functional traits for understanding community structure and composition

Matty P. Berg, Andre Dias, Nadia A. Soudzilovskaia
VU Amsterdam

Are there general laws in (community) ecology? This statement by JH Lawton in 1999 has raised considerable debate whether community ecology will ever produce general principles. There has been a call to rebuild community ecology from functional traits. Statements about traits might give generality and predictability, whereas nomenclatural ecology tends towards special cases and high context dependency.

We will give two examples, i.e. vascular plant communities in the alpine zone of the Caucasus and macro-detritivore communities in the temperate zone of Europe, to show that a functional trait approach can reveal insights in the mechanisms underlying shifts in community structure and composition under global change. Using functional traits of macro-detritivores and of vascular plants, measured in situ or under standardized conditions we will show that it is possible to produce general principles in how plant and animal communities react to changes in global climate or environmental gradients. We will formulate some challenges for future research to further develop this functional trait-based approach to govern a better understanding how global change will affect communities.

2. Integrating species traits to transform descriptive community ecology into a predictive science

Wilco C. E. P. Verberk, C. G. E. van Noordwijk
Bargerveen Foundation / Radboud University Nijmegen

The use of species traits in basic and applied ecology is rapidly expanding as trait-based approaches hold the promise to increase our mechanistic understanding of biological responses. Such understanding could transform descriptive field studies in community ecology into a predictive science. Currently, however, trait-based approaches often fail to reflect species-environment relationships adequately. The difficulties have been perceived mainly as methodological, although here we propose that the problem is more profound, touching upon the fundamentals of ecology and evolution. Selection pressures do not act independently on single traits, but on species whose success in a particular environment is controlled by many, interacting traits. Therefore, the adaptive value of a particular trait may differ across species, depending on the other traits possessed by the species and the constraints of its body plan. Because of this context-dependency, trait-based approaches should take into account the way combinations of traits interact and are constrained within a species. We present a new framework in which trade-offs and other interactions between biological traits are taken as a starting point, to provide a better mechanistic understanding of species occurrences. The framework consists of four levels; traits, trait interactions, trait combinations and life-history strategies, in a hierarchy in which each level provides the building blocks for the next. Researchers can contribute knowledge and insights at each level and their contributions can be verified or falsified using logic, theory and empirical data. Such an integrated and transparent framework can help fulfil the promise of traits to transform community ecology into a predictive science.

3. Changes in traits of alpine plant leaves in response to fertilization

Vladimir G. Onipchenko, A.A. Akhmetzhanova
Moscow State University, Russia

Plants of fertile soils tend to have relatively thin leaves with a large specific leaf area. However, at the intraspecific level, leaves increase in size upon the enrichment of soils with mineral nutrients, which may lead to a reduction of specific leaf area. In order to evaluate the consistency of the intraspecific response of plants to changes in the nutrient enrichment of soil with the general tendencies of change in leaf traits in plant communities that differ in production, we conducted an experiment in alpine plant communities in the northwest Caucasus. We studied changes in the properties of alpine plant leaves in four types of plant communities (alpine heathlands, *Fesctuca varia* dominated grasslands, *Geranium–Hedysarum* meadows, and snowbeds) in response to long term application of mineral nutrients (NP and lime). We found that, in response to soil nutrient enrichment, size-related traits of leaves (area, wet and dry mass) increased in all species except the legume *Hedysarum caucasicum*. Specific leaf area (SLA) decreased in plants from alpine heathlands, and increased in plants of snowbed community and in *Geranium gymnocaulon*, which is the dominant species of *Geranium–Hedysarum* meadows community. After a recalculation of SLA, taking into account leaf size changes, we detected that increase in leaf area leads to decrease in SLA for the majority of plant species, and a change in leaf structure in response to the application of mineral nutrients leads to increase in SLA. Species increasing SLA, also greatly increased their biomass in response to the nutrient additions.

4. Does drought-tolerance explain high liana abundance in dry forests?

Masha van der Sande, Lourens Poorter, Lars Markesteijn
Wageningen University

Lianas, or woody vines, are an important component of tropical forests, especially in those with a distinct dry season. This is paradoxical, however, because lianas have wide vessels which should increase their hydraulic conductivity, but also their vulnerability to drought-induced cavitation. Here, we analyzed for 8 liana and 13 tree species how conductivity, cavitation-resistance, and other stem and leaf traits can explain the relative advantage of lianas in drier areas. In agreement with their wide vessels, we found that lianas have a lower cavitation-resistance (i.e., they are less tolerant to drought) but a higher hydraulic conductivity. This indicates that lianas can achieve fast growth when water is not limiting, but will be the first to perish when drought increases. Hence, these properties cannot explain the relative advantage of lianas in drier tropical forests. We found a trade-off between hydraulic conductivity and cavitation-resistance for trees but, surprisingly, not for lianas. Also other traits, such as vessel length and wood density, only correlated with the cavitation-resistance of trees. This suggests that different traits are important for the cavitation-resistance of trees and lianas. What determines the drought tolerance for lianas remains unclear, and the paradox of higher liana abundance in drier tropical forests remains to be resolved.

5. Impacts of climate-driven trait variation on performance of a dynamic global vegetation model

Lieneke M. Verheijen, V. Brovkin, R. Aerts, G. Bönisch, J.H.C. Cornelissen, J. Kattge, P.B. Reich, I.J. Wright, P.M. van Bodegom
VU Amsterdam

Current dynamic global vegetation models (DGVMs) represent vegetation by a limited number of plant functional types (PFTs). Modelling vegetation based on these PFTs has serious limitations, as PFTs remain relatively inert under changing climatic conditions and therefore do not allow for variable plant responses to the environment. Flexibility in vegetation responses can be modelled by replacing a number of fixed traits by variable traits via trait-climate relationships. These relationships can be understood by the ecological assembly process of habitat filtering, which explains how the potential range of trait values and combinations in a habitat is restrained by local environmental drivers. As a consequence, global relationships between community means of many traits and climatic drivers can be found. For specific leaf area (SLA), maximum carboxylation rate ($Vcmax_{25}$) and maximum electron transport rate ($Jmax_{25}$) such relationships were implemented in PFTs of the DGVM JSBACH and allowed to vary with environmental conditions in grid cells.

Trait values in the default model strongly deviated from means of observed natural traits. Compared to the default model, the equilibrium state of the model with trait variation revealed over 35 % differences in dominant vegetation distribution and up to 50 % differences in GPP in tropical areas. Comparisons with observational data indicate a better match with biomass estimates and a vegetation map. These results emphasize the importance of implementing observation-based trait data and related ecological concepts in DGVMs, which will help to improve the modeling of vegetation in unknown climates.

6. Response of community functional properties to land use intensification in tropical ecosystems

Geovana Carreño-Rocabado, Marielos Peña-Claros, Frans Bongers, Lourens Poorter
Wageningen University / Instituto Boliviano de Investigación Forestal, Bolivia

There is a general consensus that plant biodiversity and ecosystems processes are negatively affected by land-use intensification, but, at the same time there is empirical evidence that there is a large heterogeneity in the responses. We evaluated changes in community functional properties across five land use types in the tropics that represent a long gradient in land-use intensification (LUI). We measured 12 functional traits that are related to life history, and acquisition, conservation, and use of resources. We quantified for each of the functional traits the functional composition evaluated with the community abundance-weighted mean (CWM), and functional diversity based on trait variation (coefficient of variation) and trait distribution (kurtosis).

The CWM of all 12 traits clearly responded to LUI, increase in LUI resulted in communities dominated by plants with acquisitive leaf traits such as high specific leaf area. However surprisingly, secondary forests had more conservative trait values (i.e., lower specific leaf area) than mature-and logged forest, probably because they were dominated by palms that responded to frequent burning of these secondary forests. Contrary to our predictions, functional diversity peaked at intermediate land use intensity (i.e., secondary forest and agricultural land). The high functional diversity of these systems is due to a combination of how response traits (and species) are filtered out by environmental filters and how management filters introduced “exotic – traits” into the local pool. Our results confirm the exception to the rule, not in all cases LUI results in either communities with more acquisitive traits nor in communities with less functional diversity.

1c: The Ecology of Behavioural Plasticity

Conveners: Marc Naguib (Wageningen University)
Christiaan Both (University of Groningen)

1. Personality and plasticity: consequences and underlying causes of behavioural consistency

Kees van Oers
Netherlands Institute of Ecology

Animals within populations show consistent individual variation in their behavioural response to social and non-social challenges. Describing the causes and consequences of this variation is currently one of the major issues in behavioural ecology. Sets of correlated behaviours expressed consistently within individuals indicate an individual's 'personality', analogous to a human's personality. Recent identification that many wild populations of animals consist of mixes of personalities has shifted traditional thinking of behavioural evolution.

Since different behaviours are correlated, individuals are not completely flexible in how they react to a certain challenge. Therefore they cannot optimize their behaviour in each context separately, but have to compromise to optimise fitness over the whole range of contexts has evolved. Because of these behavioural compromises there is more than one optimal solution how to cope with environmental challenges, giving rise to adaptive variation in personality phenotypes.

In this presentation I will try to give insight in how animal personality research has changed our thinking of behavioural variation and evolution. I will illustrate, with examples of our great tit model system for animal personality, what we already know and how some newly developed methods could help us to better understand behavioural evolution in natural populations.

2. Tracking the social lives of great tits: behavioural consistency in a social context

Lysanne Snijders, Erica P. van Rooij, John Burt, Kees van Oers, Marc Naguib
Wageningen University / Netherlands Institute of Ecology

Behavioural consistency makes individuals predictable and so allows other individuals to socially respond to this. Therefore it is likely that in populations with long term neighbours, selective associations and avoidances will arise. A number of recent studies show that in territorial songbird systems, like in the great tits (*Parus major*), eavesdropping can be a common phenomenon. This opens up the possibility that all individuals within hearing range can predict each other's social response, and so on forehand could know who to associate with and who to better avoid.

Until now researchers were unable to simultaneously approximate the personalities of individuals and quantify their pair-wise associations in the wild. We overcame this problem by using the new tracking technology, Encounternet, in a natural population of great tits tested for their exploration behaviour.

In March 2012 we equipped over 30 wild great tits with radio-transmitters sending signals every 5 seconds. These signals could be received by a large number of wireless stations distributed throughout the forest. By triangulating locations we were able to extract, out of several thousands of simultaneous observations, dozens of close range encounters. In this presentation I will discuss the results of this exciting new approach so far and elaborate on our plans for the future.

3. Plasticity versus personality: how plasticity in digestive processing capacity and personality of red knots interact

Allert Bijleveld, Georgina Massourakis, Annemarie Marel, Anne Dekinga, Theunis Piersma
Royal Netherlands Institute for Sea Research

Individual animals are flexible in adapting to changing environments (i.e. plasticity), but also show consistent behavioural responses (i.e. personality). Here we analyse the interaction between plasticity and personality in red knots, shorebirds specialized in eating hard-shelled bivalves. Bivalves are swallowed whole, crushed in muscular gizzards and the shell fragments excreted as faeces. The size of the gizzard sets an upper limit to the amount of shell mass that can be processed and thus delimits daily intake rates. Gizzard size is flexible within individuals and responds to the ratio between flesh and shell mass of prey (i.e. prey quality). Earlier we showed that average gizzard mass in free-living birds increased with a decline in prey quality. Individuals that were not able to increase gizzard size were not observed a year later, suggesting selection pressure on the plasticity of gizzard size. This leaves the question why not all knots increased gizzard size? Here we report of experiments that demonstrated that exploration behaviour in a novel environment (a personality trait) was repeatable (R^2 = 0.56, P < 0.01) and negatively correlated with 'field' gizzard size measured before birds were taken into captivity (R^2 = 0.23, P = 0.02), rather than at the moment of the exploration experiment (R^2 = 0.05, P = 0.31). In the field prey quality and density are inversely related, suggesting that birds with small gizzards should explore more: with a decrease in prey quality they would be expected to leave an area in search for better quality prey. A reanalysis of colour ring resightings showed that return rates (to the western Dutch Wadden Sea) after 10 years were equal for red knots captured with small and large gizzards, indicating a lack of differential

survival. We thus argue now that even though individuals adjust gizzard size to the ambient environment, their behavioural predisposition may prevent them from doing so, or even needing to.

4. How do family conflicts affect behavioural plasticity?

Camilla A. Hinde, Rufus A. Johnstone, Rebecca M. Kilner
Wageningen University

Behavioural plasticity is an important evolutionary trait, enabling individuals to respond to environmental variability, or the behaviour of conspecifics. When the interests of family members differ, how do the conflicting interests between family members affect behavioural plasticity? Here I show that great tit parents (*Parus major*) are very flexible in their response to changes in partner work rate. The extent and even direction of this response varies in relation to factors including habitat quality, age and lay date. This fits a theoretical model, which predicts that parents should vary responsiveness to their partner depending on chick quality.

Conversely, parents showed a fixed response to changes in chick begging. This may be explained by experiments with canaries, where maternal plasticity occurred pre-hatching via testosterone, which effectively 'set' mother and chick behaviour. Chicks benefited from begging at the same level that mothers prescribed for their own (cross fostered) chicks. Chicks that begged higher grew slowly, since parental responsiveness was not enough to offset costly begging. Mothers therefore do exhibit plasticity in response to chick begging, but only at the prenatal stage. Mothers reduce susceptibility to exploitation from chicks, since they will not be 'fooled' into excessive provisioning from manipulative chicks.

By 'setting' begging levels before hatching in response to environmental conditions mothers prevent exploitation by their chicks. However the family presumably pays a cost in being less able to respond to rapid fluctuations in environmental quality.

5. The cost of reproduction in a social context

Joost M. Tinbergen, R.W. Fokkema, R. Ubels
University of Groningen

Selection on reproduction works via two pathways, the benefits accrued trough the current reproduction and the parental costs in terms of their future reproduction. Although theoretically the costs of reproduction are expected to exist, outcome of avian studies vary in the success of detecting them. One reason for this could be that the social environment modulates the cost of reproduction. In our free living great tit (Parus major) population we have evidence that this is the case. Parents that cared for experimentally reduced broods survived the second half of the winter better under particular social circumstances. The hypothesis is that reproductive effort affects the competitive ability of the parents. If true interesting interactions may exist between the selection on reproduction and the competitive environment in which selection takes place. In this talk I will report on an experimental test of this hypothesis and elaborate on the consequences of our findings.

6. Modelling adaptive flight orientation among avian migrants

James McLaren, Judy Shamoun-Baranes, Willem Bouten
University of Amsterdam

Adaptation to environmental heterogeneity should be reliable over space and time, despite unpredictability and limits to perception. Optimal flight orientation among migrating birds is traditionally thought to involve partially compensating for wind drift to minimize remaining goal distance, which presumes completely unpredictable winds yet continuous goal navigation. Here we borrow from optimal control theory to extend this paradigm to optimal orientation in predictable wind regimes (omniscient steering) and test the extent to which non-omniscient steering and non-continuous goal navigation affect the speed and success of migration using an individual-based model (IBM). We show that while omniscient steering is always faster than continuous goal navigation, it involves initial headings which are highly sensitive to wind variability. With the IBM, we simulated recently tracked 7000 km non-stop migratory flights of Great Snipe (*Galinago media*) to demonstrate that neither non-omniscient steering (with uniform initial headings) nor non-continuous goal navigation (calibrated at twilight) are reliable under wind variability. Contrastingly, simulated vector-orientated flights (constant headings) with full compensation for wind drift over the last 1000 km were very reliable and nearly optimally fast. We conclude that simple vector orientation can form the basis of migration in complicated environments, and discuss extending our modelling framework to include multi-stage flights.

1d: Ecology in Practice

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

1. Improving ecosystem services by experimental ecological research: C sequestration, natural capping and peatland restoration on the former waste dump Volgermeerpolder

Sarah Faye Harpenslager
Radboud University Nijmegen

While growing peatlands play an important role in carbon (C) sequestration, degrading peatlands often become net C sources. Since peatlands store approximately one third of all soil C, they are very important in the global C cycle. Nowadays however, growing peatlands have become very rare in the Netherlands and in many other parts of Western Europe, despite many restoration efforts. Profound experimental knowledge on the optimal environmental conditions is therefore required for successful initiation of peat formation and for the restoration of these biodiverse ecosystems.

In a large field setting near Amsterdam, the Volgermeer polder, we therefore studied the initial stages of peat formation under different conditions. At this former waste dump, the largest in Western Europe, the newly developed peat will serve as a so-called 'Natural Cap' to prevent the waste from spreading into the environment. To fulfil this goal, the process of peat formation has to be optimized and the first important step in this process is the terrestrialization of open water. This can take place through three different pathways: through colonization by shore vegetation (1), by floating mire formation by sediments floating on gas production (2), and by vegetation mats formed by emergent vegetation (3). The field setting involves a set of different sediment and water quality treatments, to study which initial conditions provide the best environment in which optimal plant production and minimal decomposition of organic matter can result in the formation of peat. This knowledge is not only important for the specific situation at the Volgermeer, but also for peat formation, C sequestration and the restoration of peatland biodiversity in general.

I will discuss the results of both laboratory and field-scale experiments to show the essential role of experimental ecological research for successful application of eco-technological programs with high societal relevance.

2. Functional characteristics determine growth responses of tree species to logging and silvicultural treatments

Marielos Peña Claros
Wageningen University

To be able to manage highly diverse tropical forests, ecologist and foresters have often subjectively grouped tree species into functional groups based on their regeneration requirements. There is, however, large variation within these functional groups. For example, tree species vary largely in their growth responses to light, and therefore also in their growth response to silvicultural treatments that release them from competitors (such as lianas and other trees). Species functional traits may provide a better predictive framework to predict how species will response to release. These differences in response are relevant for forest managers as they are interested in increasing growth rates of commercial tree species, and consequently, timber yields.

In this study we linked the growth responses to release of over 35 tree species to a number of leaf traits (leaf toughness, specific leaf area), wood (wood density), and life history traits (adult stature, seed size). The study was carried out in a moist forest site in Bolivia, using data collected in the experimental plots of the Long-term Silvicultural Research Program. Results indicated that growth responses to release are related to traits typically found in light demanding species. As release treatments are costly, managers can use these traits to determine which species should be released from competitors.

3. Exploiting knowledge on habitats used by arthropods to predict value of ecosystem services in agro-landscapes

Felix Bianchi
Wageningen University

Intensification of farming practices and landscape simplification have led to a deterioration of ecosystem services in agro-ecosystems, including pollination and pest control. Maintaining effective populations of ecosystem service providers (often arthropods) hinges on the availability of resources, which is intimately linked to plant species composition of managed and unmanaged habitats in the landscape. The role of the landscape includes shelter during adverse weather in winter or summer, and provisioning of food and egg laying resources. While the critical importance of a diverse landscape for ecosystem services has been amply demonstrated empirically, it has not been unravelled why diversity is important, and which plant species support the key arthropods providing ecosystem services. Moreover, the role of the spatial configuration of habitats, including distances between sources and targets of ecosystem service providers is not clear. The lack of a mechanistic understanding on the ecological processes underlying ecosystem services, in combination with the

temporal variation in the level of ecosystem service provision, hamper the implementation of habitat management for ecosystem services in land use practice. This project envisages to fill in these knowledge gaps by a combination of literature review, modelling the foraging behaviour and resource use of arthropods, economic analysis, and analysis of stakeholder interactions in case study areas. The project will result in rules for the design of multifunctional landscapes that support ecosystem services together with other land use functions.

4. Healthy plant protection

Kirsten A. Leiss, Y. Choi, P.G.L. Klinkhamer
Leiden University

Secondary metabolites provide a tremendous potential for the generation of host plant resistance and development of natural crop protection. This is especially important in view of the rapid and vast spread of agricultural and horticultural pests worldwide. At the same time international law regulations restrict the use of pesticides. In this view we have developed the eco-metabolomic approach to identify candidate compounds related to host plant resistance. As a model we use western flower thrips (*Frankliniella occidentalis*) a major worldwide pest. Resistant and susceptible plants are identified in bioassays, whereupon their metabolomic profiles are compared using NMR (Nuclear Magnetic Resonance Spectroscopy). We applied this approach to different host plant systems such as wild plants, ornamentals and vegetables. In all systems we were able to identify compounds related to host plant resistance to thrips. Interestingly, all the compounds identified did not only show a negative effect on thrips but as anti-oxidants were also linked to positive human health effects such as prevention of cancer and cardio-vascular diseases. As such these compounds do not only contribute to a sustainable pest management but also to human health improvement. Therefore, these findings are of great relevance for practical application with plant breeders being interested in incorporating the compounds into their breeding programmes. On the other hand, our findings raise the fundamental question how can the same compound influence different organisms in opposite ways?

5. *Alexandrium* in the polder: fighting off a harmful algal bloom in zeeland with hydrogen peroxide

Amanda Burson, Hans C.P. Matthijs, Renee Talens, Wilco de Bruijne, Ron Hoogenboom, Arjen Gerssen, Kees Steur, Yvonne van Scheppingen, Anne Fortuin, Petra M. Visser, Maayke Stomp, Jef Huisman
University of Amsterdam

Previously, treatment with hydrogen peroxide (H2O2) successfully suppressed cyanobacterial blooms in lakes. We adapted this treatment to battle a toxic *Alexandrium ostenfeldii* bloom which threatened shell fisheries. Using a three-step approach including laboratory experiments, a field pilot study and finally entire Kreek treatment, cell numbers were rapidly depleted by 99% and toxins were reduced below requirements. This is the first application of H2O2 to suppress a marine HAB species and is useful for management of *Alexandrium spp.* and other HAB events.

6. When does fishing lead to more fish? Community consequences of bottom trawl fisheries in demersal food webs

P. Daniel van Denderen, Tobias van Kooten, Adriaan D. Rijnsdorp
Wageningen Institute for Marine Resources and Ecosystem Studies (IMARES) / Wageningen University

Bottom trawls are a globally used fishing gear that physically disturb the seabed and kill non-target organisms, including those that are food for the targeted fish species. There are indications that ensuing changes to the benthic invertebrate community may increase the availability of food and promote growth and even fisheries yield of target fish species. If and how this occurs is the subject of ongoing debate, with evidence both in favour and against. We model the effects of trawling on a simple ecosystem of benthivorous fish and two food populations, susceptible and resistant to trawling, and show that the ecosystem response to trawling depends on whether the abundance of benthic invertebrates is controlled by predation or competition. Fishing can results in higher fish abundance and higher (maximum sustainable) yield in a competition-driven system, where resistant invertebrates are sufficiently less affected by trawling than susceptible invertebrates, while being the most profitable prey. Fishing leads to lower fish abundance and yields in predation- or competition-driven systems without the increase in prey profitability per unit carrying capacity. This highlights the importance of mechanistic ecosystem knowledge as a requirement for successful management.

Session 2

2a: Evolutionary ecology: Genetics of adaptation to environmental shift & species interactions

Conveners: Sylvia Gerritsma (University of Groningen)
Wen-Juan Ma (University of Groningen)

1. Genetics of adaptation: A genomic approach to deciphering adaptive behaviour in a parasitoid wasp

Bart Pannebakker
Wageningen University

Knowledge on the genetics underlying adaptation is crucial if we want to understand how evolution works. However, functional genetic research of traits involved in adaptation has been relatively scarce. This is largely because these traits are typically regulated by many genes and complex epistatic interactions. Classic genetic approaches are unable to resolve such complex mechanisms. Only now, with the latest developments in genomic technology, are we able to unravel the genetic regulation of these traits.

As a case study for the role of genomics in studying adaptation, I will present my work on the genomics of facultative sex allocation in the parasitoid wasp *Nasonia vitripennis*. Sex allocation, the allocation of resources into male vs. female function (e.g. offspring sex ratio), is one of the best understood adaptive traits and it has been hailed as one of the most successful areas in behavioral and evolutionary ecology. The vast amount of theoretical and empirical research in this area means we have an extremely good understanding of the selective factors involved and it therefore stands out as a model trait with which to start exploring the genetic basis of adaptive traits.

2. Natural selection for a mutant *Nicotianamine Synthase 1* allele in a heavy metal adapted *Noccaea caerulescens* population

Ya-Fen Lin, Joop van Loon, Holger Schmidt, Yanli Wang, Henk Schat, Stephan Clemens, Judith van de Mortel, Mark G.M. Aarts
Wageningen University

Noccaea caerulescens, a Zn/Ni/Cd hyperaccumulator plant species, is a good model to study the evolution of heavy-metal adaptation in plants. Compared to related metal non-accumulator species, several metal homeostasis genes, including the *Nicotianamine Synthase* (*NAS*) genes, show enhanced expression. NAS activity is needed for nicotianamine (NA) synthesis, a metal chelator essential for proper distribution of divalent metal-ions. The *NAS1* gene shows the highest expression of four *NAS* genes, predominantly in shoots. Despite the apparent importance of this gene, we identified a mutated, transposon-insertion allele of *NAS1* (*nas1::tp*) in a natural population of *N. caerulescens* growing at a zinc mine smelter deposit in Plombières (Belgium). The transposon disrupts the normal reading frame and leads to a premature stop codon at 2/3 of the original protein.

Both mutant and wild-type alleles are found in the population, suggesting either a neutral effect on fitness, or balancing selection. When tested for metal tolerance, *nas1:tp* plants are clearly more sensitive to metal exposure than near-isogenic homozygous *NAS1* wild-type plants. In addition, they accumulate more metal in their aboveground parts. Furthermore, when feeding caterpillars of *Pieris rapae* with high Zn or high Cd treated *nas1::tp* plants, they show a stronger reduction in growth and development, compared to *NAS1* wild-type plants. Recently we discovered the mutant allele is also found in two nearby populations, Prayon and La Calamine, however, at the former, the mutant allele frequency was close to 90%, suggesting the population is experiencing a selective sweep towards 100% presence of the mutant *nas1::tp* allele.

3. Mechanisms of maintaining a hyperimmune state in populations of *Streptococcus Pneumoniae*

Monica Abrudan
University of Leiden

The mechanisms that maintain and promote bacterial biodiversity are not yet fully understood. Theoretical models have shown that the secretion of narrow spectrum toxins called bacteriocins together with high levels of toxin immunity among bacterial strains could be a mechanism that leads to the origin and maintenance of high bacterial biodiversity. Models predict that communities of coexisting bacterial will be biased towards strains that are immune to most toxins, while producing only very few toxins themselves. To test model predictions, we analysed the pairwise antagonistic interactions between 26 strains of the gram positive bacterial pathogen *Streptococcus pneumoniae*. Our experimental results support the theoretical predictions. Strains from our sample are highly biased towards hyperimmunity while they are very limited in their killing spectrum. Furthermore, we found that the frequency distribution of toxicity and immunity was highly dependent upon the timing of presentation of target strains to putative killers. This implies an important role of intercellular signaling, which induces both bacteriocin production in killer strains and immunity in target strains.

To understand this dependence, we sequenced the peptide signal inducing toxins and immunity as well as the peptide receptor. In addition, we developed novel theoretical models to simulate the evolution of toxicity and immunity in systems utilizing quorum dependent bacteriocin production, as is observed in all gram positive bacteria. Simulation results will be discussed in the context of experimental data.

4. Footprints of selection in wild populations of *Bicyclus anynana* along a latitudinal cline

M. A. de Jong, S. Collins, P. Beldade, P. M. Brakefield, Bas J. Zwaan
Wageningen University

One of the major questions in ecology and evolutionary biology is how variation in the genome enables species to adapt to divergent environments. Here, we study footprints of thermal selection in candidate genes in six wild populations of the afrotropical butterfly *Bicyclus anynana*, sampled along a ~3,000 km latitudinal cline. We sequenced coding regions of 31 selected genes with known functions in metabolism, pigment production, development, and heat shock responses. These include genes for which we expect a priori a role in thermal adaptation and, thus, varying selection pressures along a latitudinal cline, and genes we do not expect to vary clinally and can be used as controls. We identified amino-acid substitution polymorphisms in 13 genes and tested these for clinal variation by correlation analysis of allele frequencies with latitude. In addition, we used two FST-based outlier methods to identify loci with higher population differentiation than expected under neutral evolution, while accounting for potentially confounding effects of population structure and demographic history. Two metabolic enzymes of the glycolytic pathway, UGP and Treh, showed clinal variation. The same loci showed elevated population differentiation and were identified as significant outliers. We found no evidence of clines in the pigmentation genes, heat shock proteins and developmental genes. However, we identified outlier loci in more localized parts of the range in the pigmentation genes yellow and black. We discuss that the observed clinal variation and elevated population divergence in UGP and Treh may reflect adaptation to a geographic thermal gradient.

5. Adaptation and Heterogeneity of *Escherichia coli* MC1000 Growing in Complex Environments

Pilar Puentes
University of Groningen

In an attempt to assess bacterial evolution in complex environments, we evaluated the long-term adaptive response of *Escherichia coli* MC1000 in Luria-Bertani (LB) under three different oxygen conditions. Seven parallel populations were founded and followed over 150 days in continuous cultures using constant and fluctuating transfers. After this time, a total of 19 end-point evolved forms were isolated.

The emergence of forms with enhanced fitness was evident in competition experiments of all evolved forms versus the ancestral strain. The evolved forms were then subjected to phenotypic and genomic analyses relative to the ancestor. Profound changes were found in their phenotypes as well as whole-genome sequences. Interestingly, considerable heterogeneity was found even at the intrapopulational level. Clearly treatment effect appeared as a main driving force of adaptation; however, diversification was driven by the multiplicity of substrates. Consistently occurring parallel adaptive responses were found across all populations likely driven by the medium which suggests a crucial role of LB medium in the genotypic and phenotypic adaptive response. The evolved forms all contained a mutation in galR, a repressor of the galactose operon. Concomitantly, the new forms revealed enhanced growth on galactose as well as galactose-containing disaccharides.

6. Quantitative genetics, selection and photosynthesis in *Arabidopsis thaliana*

Pádraic J. Flood, Jeremy Harbinson, Jan F.H. Snel, Henk Jalink, Rob van der Schoor, Mark G.M. Aarts
Wageningen University

Photosynthesis is a complex trait affected by many genes acting from the biochemical to the morphological level. The difficulty in accurately phenotyping photosynthesis has prevented quantitative genetic studies up until very recently. In order to overcome this we developed a phenotyping platform capable of analyzing 1440 plants several times per day for photosynthesis and related traits. Such an increase in phenotyping capacity allowed us to screen multiple mapping populations in order to identify QTLs responsible for natural genetic variation in photosynthesis. Apart from identifying QTLs, we were also provided with some insights into the selective forces which appear to be acting on photosynthesis in the field. These insights will be discussed from an evolutionary, plant breeding and ecological perspective.

2b: Exotic species: An addition or a plague?

Conveners: Bart Grutters (Netherlands Institute of Ecology)
Ivo Roessink (Wageningen UR)
Anne Immers (Netherlands Institute of Ecology)

1. Exotic species: benefits or plague

Ivo Roessink
Wageningen UR

When species expand their territory on their own accord, i.e., because of improved climatological conditions, this is generally considered being a natural phenomenon as for instance was the increase of the wasp spider in recent years. However, some other species like Louisiana crayfish, red-eared sliders, racoons, and Ambrosia, used man-made structures (e.g., canals or ships) or, even more directly, were actively transported by humans. Once they established themselves, their arrival was perceived with different eyes.

In general, a species can only establish itself when it can find or make itself a niche. From here it may either persist or expand rapidly and consequently can be characterised as a mere exotic addition to the system or a true invader. In both cases, however, the species will have a lesser or greater influence on the ecosystem. Whether this is a good or bad influence is subject to debate. Detrimental effects are usually more easily and more quickly observed and consequently receive attention. Positive effects might occur as well, however, are less frequently reported. Is this because they are not being monitored properly, they are not there (yet), or is it all the eye of the beholder?

2. Do exotic plants in the Netherlands affect plant diversity?

T. van Hengstum, P.G. Meirmans, J.G.B. Oostermeijer, P.H. van Tienderen
University of Amsterdam

The Dutch flora contains about 400 exotic species. A number of these have become invasive and pose potential threats to native plant diversity. Much is unclear about the impact of exotic plants on native plant diversity, or why some habitat types are more susceptible to colonization by exotics than others.

In this study we used a dataset of more than 10.000 periodically monitored quadrats in the Netherlands to address the following questions: (1) Do exotics occur in less diverse habitats than native species?, (2) Does native plant diversity and cover decrease following colonization by an exotic species? and (3) Do exotics have a wider/different ecological niche than native species?
We demonstrate that habitat of exotic species has a significantly lower alpha-diversity than that of natives. However, an increase in the number of exotics did not significantly decrease local plant diversity. Furthermore, while the average niche width is the same for exotic and native species, very common exotics actually have a broader niche than comparable natives. Finally, we show that exotics are found in significantly shadier, warmer, more continental and more nutrient rich vegetation types than native species.

Our results give important insight in the causes and consequences of colonization by exotic plants in the Netherlands and may aid in management prioritization of invasive species.

3. Patterns of impact of three invasive plant species on freshwater ecosystems

Iris Stiers, Ludwig Triest
Vrije Universiteit Brussel, Belgium

Alien plant invasions are considered a threat to biodiversity, yet the relative importance of the different patterns of impact is poorly understood. We investigated the community impacts of three invasive aquatic weeds, *Hydrocotyle ranunculoides*, *Myriophyllum aquaticum* and *Ludwigia grandiflora*, on native plants, macroinvertebrates and pollinators. Both direct (via resource competition) and indirect (via pollination) patterns of impact were studied. Native plant / benthic invertebrate richness, abundance and composition were compared between invaded and uninvaded sites in close vicinity. To study the impact on pollinators an experimental design was set up to estimate the pollinator-mediated effect of the relative floral abundance (cover) of *L. grandiflora* on native potted *Lythrum salicaria* plants. Our research on 32 sites in Belgium indicated that the reduction in native plant species richness was a common pattern to invasion. However, the magnitude of impact was species specific. A strong negative relationship to invasive species cover was found, with submerged vegetation the most vulnerable to the invasion. Impacts proliferated to other functional groups with a strong negative relationship between invasive species cover and invertebrate abundance. Competition for pollinator services seems minor as there was no evidence for decreased pollinator visitation rate or seed number of the native *L. salicaria*. On the contrary, results showed that more insects were recorded on the native counterpart when the cover of the invasive species was low compared to the control plants ('facilitation' effect). Overall, the impacts on the different functional groups were variable, but related to cover of the invasive plant studied.

4. Impact and spread of alien macroinvertebrates in surface waters in Flanders

Pieter Boets, Koen Lock, Peter L.M. Goethals
Ghent University, Belgium

Flanders, situated in the northern part of Belgium, is a highly urbanised area that is characterised by a large number of navigable canals and inland and coastal harbours, which are frequently visited by international ships. We investigated the impact and spread of alien macroinvertebrates in three different systems: (1) the harbour of Ghent, a previous degraded water body, (2) the polders, which are characterised by brackish water conditions and low natural species diversity and (3) the coastal harbours. Rehabilitated systems or systems that have recently undergone serious changes in environmental conditions were likely to be invaded by alien species. Mainly large watercourses with a good chemical water quality and hard bank structures, harbours and brackish polder waters are favourable for alien macroinvertebrates to establish. In the studied systems, alien species can be considered as the 'passengers' rather than the 'drivers' of ecological change. Predictions on the future distribution, based on modelled changes in chemical water quality, indicated that alien species are likely to continue their spread especially in those watercourses evolving from a bad to a moderate or good ecological status. Although native species are considered to have a competitive advantage in natural habitats with a high ecological water quality, we should be cautious about certain alien invasive species since in systems with a high biodiversity they can have a negative impact both on the community as well as on the biological assessment.

5. Assessing and comparing invasive dreissenid mussels

Michiel Verhofstad
Netherlands Institute of Ecology / Radboud University Nijmegen

There are a lot of different mechanisms and species traits which can help explain why a certain non-native species becomes invasive to a specific environment and another does not. Two similar bivalve species have both managed to become invasive in a large part of the temperate freshwater world and continue to invade new systems. Both species are dreissenids, namely *Dreissena polymorpha* (Zebra mussel) and the lesser known *Dreissena rostriformis bugensis* (Quagga mussel). These species can have a large array of effects on an (invaded) ecosystem, but also man-made systems due to several species traits and factors. They can take up a central role in an ecosystem and function as eco-engineers. Because of these ecological and financial effects, a lot of research has been conducted in the past, especially on the Zebra mussel. Both species have been found able to invade the same water body while being very similar to each other and thus likely to be competitors for the same resources. Indications of niche differentiation (over depth in lake) or displacement by one species have been seen in the field.

This sparked my interest and is the reason why I and my co-workers started a field experiment where we transplanted both species to different depths of a lake for 4 months and monitored their survival, growth and nitrogen and carbon stable isotope ratios. We found both similar and totally different reactions to depth between the two species, depending on the depth.

6. Negative impact of invasive Ponto-Caspian gobiid fish species on the densities of the native Bullhead (*Cottus perifretum*) in the River Meuse: its cause and mechanism

Martijn Dorenbosch, Nils van Kessel, Rob Leuven, Gerard van der Velde
Radboud University Nijmegen

It has been hypothesized that the success of Ponto-Caspian invaders in the Rhine and Meuse can partly be explained by the absence or low density of equivalent native species that drastically declined by poor water quality during the 20th century. Since native species were absent from river habitats, direct effects of Ponto-Caspian invaders on native species are difficult to quantify.

However, the strong increase of the native Bullhead (Cottus perifretum) population in the 1990's due to water quality improvement in the Meuse followed by a recent decline coinciding with the appearance of Ponto-Caspian gobies, is an exception. Since 2008, the Meuse has sequentially been colonized by gobiid fish (Proterhorinus semilunaris, Neogobius kessleri, and Neogobius melanostomus). Based on monitoring programs, we were able to quantify the effects of the gobiid invasion on native Bullhead. Settlement of gobiids greatly reduced distribution of Bullhead as increasing gobiid densities coincided with a decline of Bullhead densities.

Additionally, controlled lab experiments with respect to competition for shelter and feeding behaviour were conducted, as well as a stable isotope study to determine trophic position and diet of the species. Based on stable isotopes, gobiids and native Bullhead show a large diet overlap. Lab experiments additionally showed that gobiids are territorial and can win competition for shelter from Bullhead. Furthermore, gobiid species were opportunistic feeders that can ingest more food in comparison with Bullhead. In conclusion, competition for shelter and food by invasive gobiids may be important mechanisms that partly explain the decline of Bullhead.

2c: Coastal Ecology

Conveners: Tjisse van der Heide (Radboud University Nijmegen / University of Groningen)
Marjolijn Christianen (University of Groningen)

1. Ecosystem engineers as the foundation of coastal ecosystems

Tjisse van der Heide
Radboud University Nijmegen / University of Groningen

Coastal ecosystems are often typified by hostile environmental conditions: intense hydrodynamics (currents & waves), highly anoxic, poisonous sediments, and severe fluctuations in salinity and temperature. Keystone species of these systems, like for instance seagrasses, salt-marsh plants, or mussels, can often only survive by modifying their environment to their own benefit (e.g., reduction of hydrodynamics, aeration of sediments). This active habitat modification, called “ecosystem engineering”, typically increases with increasing density of the habitat-modifying organism (the ecosystem engineer). This results in a feedback loop: more organisms lead to better growth conditions, in turn leading to more organisms again. The changes in habitat conditions are not only important for the ecosystem engineers, but also affect the abundances and spatial distribution of a wide array of associated species like crabs, fish, turtles and waterbirds.

2. Modelling biota-sediment interactions in estuarine environments

Francesco Cozzoli
Netherlands Institute of Sea Research

Future choices about the realization of hydrodynamic infrastructures in estuaries should be based on solid forecast about the changes they will generate in the environment. While complex numerical models are available for simulating sediment transport on physical basis, biologic elements are still hard to predict. This research project is aimed towards the integration of physical and biological insights in sediment transport models. As first step, we modelled the macrozoobenthic species spatial distribution in estuarine environments as function of those environmental variables that are relevant for sediment transport. As second step, we measured in laboratory conditions the effect of several macrozoobenthic species on sediment erodability. These observations describe ecological processes but are based on physical parameters. They can be used to parameterize semi-empirical models of biotic-mediated sediment dynamics, thus accounting for the biotic-induced deviations of sedimentary processes from purely physical expectations. This project is part of the innovative program Building with Nature.

3. Importance of spatial patterns in the persistence of new-settled mussel beds in the Wadden Sea

Hélène de Paoli
Netherlands Institute of Sea Research

In the western Wadden Sea, stable mussel beds have experienced as stark decline in 1989 and 1990, and all disappeared from this area. This decline has had a big influence on the entire ecosystem, as mussel beds are ecosystem engineers, providing refuge for many species, and filtering the water. To improve the prospects for restoration of mussel beds, we will try to understand the mechanisms determining to the establishment and persistence of restored mussel beds. An important characteristic of establishing intertidal mussel beds is the presence of both small-scale (clumps or strings separated with bare sediment) and large-scale patterns (hummocks). We hypothesize that these patterns (aggregations) are favorable for the persistence of mussel bed, by helping them to resist hydrodynamic and predation stress. To test this hypothesis, 20 artificial mussel beds were set up in the Wadden Sea near Schiermonnikoog, with different large-scale and small-scale aggregation treatments. The persistence of the bed over time was surveyed by analyzing aerial pictures. The results show that the beds with small-scale aggregation and/or large-scale aggregation persist longer on the mudflat. We conclude that first, small-scale aggregation is an important driver of bed persistence. Second, large-scale aggregation promotes small-scale aggregation, and hence indirectly helps the bed to resist the waves and currents. Concluding, mussels were found to use self-organization at two scales to modify their habitat, and resist hydrodynamic conditions. Hence, generating artificial aggregation in restoration projects, based on the selforganized patterns observed in nature, can help the restoration of mussel beds in the Wadden Sea.

4. A three-stage symbiosis forms the foundation of seagrass ecosystems

Laura Govers
Radboud University Nijmegen

Seagrasses evolved from terrestrial plants into marine foundation species around 100 million years ago. Their ecological success, however, remains a mystery because natural organic matter accumulation within the beds should result in toxic sediment sulfide levels. Using a meta-analysis, a field study, and a laboratory experiment, we reveal how an ancient three-stage symbiosis between

seagrass, lucinid bivalves, and their sulfide-oxidizing gill bacteria reduces sulfide stress for seagrasses. We found that the bivalve–sulfide-oxidizer symbiosis reduced sulfide levels and enhanced seagrass production as measured in biomass. In turn, the bivalves and their endosymbionts profit from organic matter accumulation and radial oxygen release from the seagrass roots. These findings elucidate the long-term success of seagrasses in warm waters and offer new prospects for seagrass ecosystem conservation.

5. Green turtles that 'dig' for dinner and seagrass collapse

Marjolijn Christianen
Radboud University Nijmegen

Desertification due to intensive grazing is described for many ecosystems. An increasing number of studies demonstrate that degradation of those systems is not only dependent on herbivore density but also on abiotic factors hampering plant recovery. For a relatively simple seagrass-grazer (*Halodule uninervis* - green turtle, *Chelonia mydas*) system, we introduce a newly discovered destructive grazing strategy 'digging' of an exceptionally dense green turtle population. Surprisingly green turtles not only graze on leaves but also 'dig' for roots and rhizomes and thereby initiate a spatial 'leopard' pattern of gaps in seagrass meadows. Using broad-scale long-term observational data we show that the green turtle density and digging intensity are increasing. Data from experimental gap clearings showed that decreased regrowth and increased erosion are the major explaining factors hampering recovery. By using a fully parameterized predator-prey model, we show that a mismatch between seagrass regrowth, erosion stress and grazing ('digging') pressure potentially leads to alternative stable states, which amplify the likelihood of an irreversible collapse of vital seagrass meadows. We furthermore discuss the possible strategies for conservation strategies to avoid, or navigate away from undesirable phase-shifts.

6. Emergent community effects and life-history characteristics of a predatory fish

Floor Soudijn
University of Amsterdam

Marine predator populations have declined rapidly over the last decades in response to increasing fishing pressure. In some cases, overfishing has resulted in a collapse of the predator. Alarmingly, overfished Cod populations in both the North West Atlantic and Baltic Sea remain low, despite serious fisheries management measures. Data indicate alternative stable states in these systems. We explore the possibility to explain the observed states based on mechanisms intrinsic to the marine community. Classical theory considers populations as a collection of average individuals. However, distinguishing between juvenile and adult individuals allows for more complex model dynamics that might explain the observed alternative stable states. Cod, that shows a size-dependent prey preference may alter the prey population to its own benefit. This results in Cod persistence at high cod densities while when reduced to low densities Cod is unable to recover. So far this effect, usually referred to as the Emergent Allee effect, has only been described in models with continuous reproduction. In addition, the role of complexity in the Cods' life history is not yet totally understood. In this study, we test the robustness of the Emergent Allee effect to pulsed reproduction for the fish species and two diet shifts in Cods life history.

2d: Ecology of Urbanisation

Conveners: Kamiel Spoelstra (Netherlands Institute of Ecology)
Roy van Grunsven (Wageningen University)

1. Ecology in an urban world

Roy H.A. van Grunsven
Wageningen University

Large parts of the world are densely populated and consist mainly of highly anthropogenic environments. This affects the local ecology, some species benefit from these changes while other suffer. However the ones that benefit are not always the species we like. Furthermore urbanisation does not just result in the loss of old and creation of new habitat types but also alters the environment through e.g. anthropogenic noise and light pollution. Although these changes have long been neglected there is an increasing awareness. The first steps in understanding the impact this has on the natural environment are currently being undertaken. The LightOnNature project, where we study the effect of artificial light on nature is an example of this.

2. Only sex with the lights off? Moth reproduction in illuminated nights

Koert G. van Geffen
Wageningen University

Nocturnal animals in urban and sub-urban areas are increasingly confronted with artificial illumination of their habitat. This potentially has adverse effects on their population sizes. Moths, for example, have shown dramatic declines in population sizes over the past decades, and these declines are often – at least partly – ascribed to negative effects of artificial light on moths. However, studies on moths and artificial light so far focused only on phototaxis (attraction to light), whereas other mechanisms that underlie potential artificial light induced moth declines remain unknown. Here I will present novel results from studies on the effects of different types of artificial light on moth reproduction. Our results show for the first time that artificial light effects extend far beyond phototaxis and can affect behavioural and physiological processes that are crucial determinants of population sizes.

3. Nocturnal illumination affecting birds' activity patterns

Maaike de Jong
Netherlands Institute of Ecology

Light pollution has increased dramatically over the past decades. Evidence for short term effects of anthropogenic illumination on several species groups exists, but experimental studies are few. In birds, photoperiod is the main cue for timing of daily and seasonal activity. Traditional (white) lighting has shown to affect laying dates, timing of dawn song, chick feeding rates and disturb nocturnal migration. The current change to LED outdoor lighting might allow a possible reduction in negative effects by using different light spectra. Nocturnal illumination is expected to affect daily activity patterns, however no knowledge yet is available on the wavelength dependent effects of low intensity night lighting. We measured daily activity of individually housed blue tits which were exposed to 14 hours of daylight and 10 hours of either darkness or low intensity white, green-blue or red light. There were significant differences in the onset of activity between the four treatment groups; blue tits illuminated by green-blue light at night on average woke up earlier than control group birds, but not as early as those exposed to white or red light. This indicates that blue-green light disturbs avian daily activity patterns less than red or white light. Studies on seasonal activity yielded comparable results; short wavelengths had a smaller effect than long wavelength light on gonadal development, a measure of seasonal timing of reproduction in birds.

4. "Verlust der Nacht" – an interdisciplinary research project addressing the effects of artificial light at night

Stephanie I.J. Holzhauer, Franz Hölker
Leibniz-Institut für Gewässerökologie und Binnenfischerei (IGB), Germany

In the interdisciplinary research project "Loss of the Night", funded by the German Federal Ministry of Education and Research (BMBF), scientists investigate the reasons for the increasing illumination of the night, its ecological, cultural and socioeconomic effects, and the effects on human health. The results of this research will help us to develop improved lighting concepts and sustainable technologies. The presence of light at night is one of the most obvious hallmarks of human habitance in an ecosystem. The rapid global increase of artificial light in quantity (0-20% per year depending on geographic region) and the change in the colour spectrum of public lighting have fundamentally transformed nightscapes over the past six decades.

Since 2010 the interdisciplinary research project "Verlust der Nacht" ("Loss of the Night") with 14 subprojects studies the ecological, health-related and cultural and socioeconomical effects of artificial light at night (www.verlustdernacht.de). The ecological focus is on the questions, whether light has an effect in aquatic and adjacent terrestrial habitats and to which extent, how light or parts of the

light spectrum affect the different organisms, and are there spatial and temporal relationships in their reaction. The project encompasses urban and semi-natural areas and takes insects, fishes, bats, and birds into consideration. The talk gives a general introduction into the topic and provides first results of the project.

5. Emergence of Household pests in The Netherlands

Bruce Schoelitsz
Kenniscentrum Dierplagen (KAD) / Wageningen University

Urbanisation affects ecosystems by human activity. New habitats are created and existing ones are altered. This may directly or indirectly increase the local and global ranges for species that benefit from urbanisation. This phenomenon is seen within the household environment in The Netherlands. Data from identifications performed by KAD in over a decade have been analysed and show that two common species that cause considerable nuisance and damage are the Grey Silverfish (*Ctenolepisma longicaudatum*) and the Brown ant (*Lasius brunneus*). The Grey Silverfish is an exotic species that has spread throughout the entire country and shows a strong correlation between nuisance experience and age of the building. Eradication of this species is hard and chance of reintroduction is high. The Brown ant is an indigenous species that is mainly found inlands. When taking into account the ants nesting within buildings, the geographical range spreads and includes the coastal areas. Infestations of these ants within a building are possible when wood and/or insulation materials are moist and are mainly noticed because of small shavings of building materials found on the floor. Treatment with insecticides is not effective. The only suitable solution is removing the nest and eliminating the cause of the moist circumstances, as shown in a case study.

6. Insex and the city: urbanization as driver of emerging infectious diseases

Sander C.J.M. Koenraadt
Wageningen University

Over the past few decades, the world has experienced an increase in the number of infectious diseases. Urbanization, global trade and travel, and climatic changes have been brought forward as important drivers of these trends, but the debate has far from settled. Some of these diseases result from direct contact (e.g. SARS and avian flu), whereas others have a more complex transmission cycle and pathogens have to pass through intermediate hosts (e.g. birds, rodents and insects) before affecting humans. Examples are hanta virus, dengue and West Nile fever. For latter group of diseases, urban areas are of particular concern, because it is often here that people, parasites and their intermediate hosts meet and cause social and economic harm. In this presentation, specific attention will be paid to the risk of West Nile fever on the European continent.

Session 3

3a: Trophic Interactions

Conveners: Ciska Veen (Netherlands Institute of Ecology / Swedish Agricultural University)
Tess van de Voorde (Wageningen University)

1. Linking plant-soil feedback and belowground-aboveground interactions

T. Martijn Bezemer
Netherlands Institute of Ecology

Plant-soil feedback and belowground-aboveground interactions are currently two hot topics in ecology. In both research fields soil organisms play a central role, but so far these fields have developed separately. Belowground-aboveground studies focus on the effects of root herbivores or other soil biota on aboveground insect herbivores and their natural enemies via changes in the primary and secondary chemistry of the shared host plant. These studies typically examine interactions that occur simultaneously and on a single plant, thereby ignoring the potential of legacy effects of herbivory on later growing plants via changes in soil biotic or abiotic conditions. However, both belowground and aboveground herbivory can influence the soil microbial community, for example via their effects on the amount or chemical composition of roots and root exudates. Plant-soil feedback studies on the other hand focus on the effects of plants on the performance of other plants that grow later in the soil via changes in the composition or abundance of soil biota, or via changes in soil nutrients. The vast majority of plant-soil feedback studies have focused on the feedback effects on plant biomass without studying the effects on plant nutritional quality. However, interactions with soil biota such as bacteria, AMF, pathogenic fungi, or root feeding nematodes can also influence the chemical composition of both roots and aboveground plant parts. In this presentation, I will argue how plant-soil feedback effects via affecting plant nutritional quality can influence belowground-aboveground interactions; and (ii) how belowground-aboveground interactions can affect plant-soil feedback responses. I propose that plant-soil feedback and belowground-aboveground interactions should be considered concurrently, and that these temporal spatial dynamics between plants, soil organisms and aboveground insects can be a major factor that determine the composition of communities in natural ecosystems.

2. Effects of intraspecific variation in plant defense on aboveground and belowground herbivores of ribwort plantain, *Plantago lanceolata*

Jinghua Huang, T.M. Bezemer, A. Biere, W.H. van der Putten
Netherlands Institute of Ecology

Although plant-mediated interactions between aboveground and belowground herbivores have received considerable attention, the results are extremely variable. Intraspecific variation in plant defense is an important factor that influences the interactions between aboveground and belowground herbivores. Until now, most studies focused on investigating effects of intraspecific variation in plant defense on aboveground herbivores, while very few attention has been paid on response of belowground herbivores. In this study, a greenhouse experiment was carried out to investigate effects of intraspecific variation in plant defense among 10 lines of ribwort plantain, *Plantago lanceolata*, on performance of aboveground and belowground herbivores. The aim of the experiment was to test two hypotheses: (i) Intraspecific variation in plant defense has similar effects on aboveground and belowground herbivores; (ii) Belowground herbivores affect aboveground herbivores by inducing changes in plant secondary compounds. We used wireworm (*Agriotes lineatus*) and nematodes as belowground herbivores, and aphid (*Myzus persicae*) and leaf chewing caterpillar (*Spodoptera exigua*) as aboveground herbivores. The results showed that herbivores with different feeding strategies show different responses to intraspecific variation in plant defense. Performance of nematodes and aboveground herbivores on ten *P.lanceolata* lines are positively correlated. Nematodes exert genotype-dependant effects on performance of aboveground herbivores and the effects on caterpillar performance can be explained by induction of leaf IG concentration. This experiment will provide a better understanding of the effects of intraspecific variation in plant defense on aboveground-belowground interactions.

3. Seasonal phenology of interactions involving multivoltine herbivores and their endoparasitoid wasp

Minghui Fei, Rieta Gols, Jeffrey A. Harvey
Netherlands Institute of Ecology

Special-temporal realism is missing in many studies on the mechanism of tri-trophic interactions. We studied interactions involving three species of cruciferous plants that exhibit different seasonal phenologies on the development of a multivoltine herbivore, the large cabbage white butterfly, and its gregarious endoparasitoid wasp. Insects were either reared on each of the three plant species (*B. rapa*, *S. arvensis* or *B. nigra*) for three successive generations or shifted between generations from *B. rapa to S. arvensis* to *B. nigra* reflecting the phenology of these plants in the Netherlands. We

measured development time from egg hatching to pupation and pupal fresh mass as proxies for herbivore performance. Parasitoid performance parameters (development time from egg to adult and adults fresh mass) were measured for each sex and we consider the brood sizes. Our results shown that both plant quality and phenology have effects on insect performance; phenological effects on development time and biomass are influenced by food-plant species. Food-plant shift affected development time or adult body mass depending on the food-plant to which the host was transferred.

4. Trophic interactions reduce terrestrialisation and plant diversity in riparian vegetation

Liesbeth Bakker, Judith Sarneel, Ciska Veen
Netherlands Institute of Ecology

Terrestrial and aquatic ecosystems are strongly interconnected. Riparian vegetation grows on the border between land and water and performs several ecosystem services and functions as important reservoir of plant biodiversity as well as habitat for fauna. However, in eutrophicated systems, the border between land and water can be very abrupt as riparian vegetation is declining and colonisation of open water by riparian plants is absent in many restoration projects. Abiotic factors, such as eutrophication and physical factors, such as wave action, have been thought to regulate plant diversity and terrestrialisation. However, the role of biotic factors and trophic interactions has been largely ignored. We experimentally tested whether trophic interactions may explain reduced terrestrialisation and affect plant diversity in riparian zones. We performed a field exclosure study in 10 wetlands and measured the interactive effects of eutrophication and vertebrate grazing on riparian plant growth and diversity. We found that vertebrate grazers, such as waterfowl and muskrats, play an important structuring role in the riparian zone.

5. Belowground overyielding in a long-term biodiversity experiment

Janneke Ravenek, Liesje Mommer, Hans de Kroon
Radboud University Nijmegen

With this study we aim to show how plant-soil feedback can explain long-term belowground overyielding in semi-natural communities. Plant biodiversity itself and high biomass production are important for ecosystem functioning at multiple trophic levels aboveground and belowground, as well as for nutrient cycling. Plant roots comprise up to 60-80% of plant community biomass. Evidence is accumulating that overyielding, well-studied aboveground, also happens belowground. However, very few temporal studies exist on the development of belowground biomass patterns in natural environments. We studied whether belowground overyielding occurs similarly to aboveground in a large biodiversity experiment. Additionally we aimed to find evidence for niche complementarity as explanation for overyielding in biodiverse communities. We analyzed root standing biomass of a 1-16 species richness gradient (between 2003-2011) in the Jena Experiment. We found that belowground overyielding was three years delayed compared to aboveground overyielding. We did not find evidence for niche complementarity belowground. We discuss how bi-trophic interactions may be able to explain biomass patterns in the Jena experiment. Plant-soil feedback has recently gained attention as prime mechanism behind the much-observed biodiversity-productivity relationship. As we did not find evidence for plant-plant competitive/complementary interactions for nutrients, we suggest that belowground plant-pathogen interactions and release of pathogen pressure enables belowground overyielding. The effects of belowground plant-pathogen interactions on carbon sequestration are briefly discussed.

6. Overyielding in plant species mixtures: a key role for belowground trophic interactions?

Gerlinde B. De Deyn, Helen Quirk, Simon Oakley, Nick J. Ostle, Richard D. Bardgett
Wageningen University

Plant species richness and productivity often show a positive relationship, but the underlying mechanisms are still not fully understood. Using a ^{13}C pulse labelling approach we tested whether plant individuals grown in monocultures and in mixtures with other plant species have differential rates of short-term carbon (C-) translocation to the belowground, and whether such short-term responses are reflected in biomass yields. We found that plant individuals of both the legume *Trifolium repens* and the grass species *Anthoxanthum odoratum* showed faster C-translocation and overyielding when grown in species mixtures, a response likely mediated by mycorrhizal fungi that function as a strong carbon sink. Moreover, in contrast to earlier studies we found overyielding in species mixtures to be associated with lower nitrogen use efficiency and higher carbon use efficiency, with a key role for belowground interactions.

3b: Adaptation to climate change across time and space

Conveners: Tom Reed (Netherlands Institute of Ecology)
Marleen Cobben (Wageningen University)

1. Changing phenology when phenotypic plasticity does not suffice: evidence for evolution in action?

Christiaan Both
University of Groningen

Climate change alters seasonal ecological interactions, and because observed phenotypic responses are often insufficient, evolutionary changes are required. Here we show that *Ficedula* flycatchers are adapting their annual timing through a combined phenotypic flexible and possibly an evolutionary response. Because the individual flexible response was weaker than the mean population response, flycatchers lay at present up to a week earlier with the same temperature than 30 years ago. This effect differed across Europe, being strongest in regions with most spring warming. This possible evolutionary response was predicted by observed heritability and selection on annual timing. We hypothesize that populations in warming regions could evolve because survival selection for early arrival and breeding has weakened as temperatures upon spring arrival have increased and female survival consequently increased over the years. Whereas rapid evolutionary response may allow some species to adapt, our observed rate of adaptation in flycatchers is still less than the advance in timing of a major food source, and as a result major local population declines have been reported.

2. Evolutionary response of egg hatching date of an herbivorous insect under climate change

Lucia Salis
Netherlands Institute of Ecology / University of Groningen

Under changing climatic conditions species need to adapt to their new environment for which genetic adaptation (micro-evolution) is crucial. Moreover, if the rate of adaptation is not as fast as the rate of environmental change, this may have major consequences on population viability. We present one of the few examples of genetic changes in wild populations in response to climate change. Recent increases in spring temperatures have led to phenological mismatches between many herbivores and their food plant. In the winter moth *Opheroptera brumata*, mismatched egg hatching has severe fitness consequences on growth, survival and reproduction, as newly hatched caterpillars can feed only on fresh oak's leaves. Based on a genetic model, we estimated the expected rate of genetic change in the egg hatching date plasticity in response to temperature. Using both long-term observational data and experiments, we show that plasticity in egg hatching date has changed genetically in a period of 10 years, resulting in closer synchrony with oak bud burst. Hence, altered selection pressures, caused by environmental change, resulted in a rapid adaptive response in insect phenology. These genetic changes in a key life-history trait in this herbivorous insect therefore seem to be fast enough to match the climate-change-induced advancement of their host phenology.

3. Space is not time! A theoretical model of dietary restriction responses in temporally and spatially varying environments

Joost van den Heuvel, Paul M. Brakefield, Thomas B. L. Kirkwood, Bas J. Zwaan, Daryl P. Shanley
Leiden University

It is well described that upon dietary restriction (DR) many organisms increase their lifespan. It is also often emphasized that the DR response is conserved between all animal taxa, but there are many exceptions and a full explanatory theoretical model has as yet only been produced for mice. Here we describe a resource acquisition and allocation model based on the principles of the disposable soma theory and the Y-model. In this model the environment varies temporally and spatially in food availability and in the level of predation in which organisms are selected to optimize lifespan and reproduction. We then examine whether this range of environments aimed at representing the conditions in which animals have evolved across the evolutionary tree, favours a plastic response that resembles the empirically described DR response. In our model DR response only evolves in a temporally varying environment when variation in food availability correlates with juvenile survival and when extrinsic mortality is low, enabling organisms to experience different 'seasons'. In spatially varying environments organisms only increase lifespan upon DR if investment in reproductive bouts is very short. We therefore conclude that temporal and spatial heterogeneity differ in their effects on the chance that the DR response will evolve in a lineage, and that it is not expected to be conserved over the whole evolutionary tree. Most notably, our theoretical results indicate that DR is unlikely to evolve for organisms in which food availability at the time of reproduction does not influence juvenile survival.

4. Climate change and weather extremes: are there reasons to be worried?

Agnieszka H. Malinowska
Wageningen University

There is a research consensus that global climate change has profound effects on animal (meta) populations. While there is convincing evidence for range shifts and average temperature rise, the evidence for effects of extreme weather events on animal (meta) populations is less common, mostly with examples of singular species or extreme events. To see if there are patterns visible across whole taxonomic groups, we analysed colonisations and extinctions in relation to weather, in four groups of organisms: dragonflies and damselflies, grasshoppers, butterflies, and reptiles. We retrieved data from the National Database Flora and Fauna, which collates data of various quality and sources. For the above-mentioned groups, we were able to cover their whole range in the Netherlands on a 1x1km-grid base, year-by-year for the last ca. 20 years. We did not find evidence that these groups are susceptible to weather extremes that occurred during the study period. Even years 2003 and 2006/7, that are commonly perceived as extreme in the Netherlands, did not leave a fingerprint in our data. We conclude therefore, that there are other factors, beyond weather extremes, that have more influence on distribution and metapopulation dynamics of the animal groups studied. Possible factors are: habitat quality and management, availability of microhabitats with suitable microclimates, change in weather averages rather than extremes. An alternative explanation is that species are so unique in their response to environmental factors that by combining all species within a group individual effects are averaged out.

5. Adapting forest management to climate change – impacts of (anticipated) climate change on forest dynamics

Geerten Hengeveld, Markus Didion, Sandra Clerkx & Mart-Jan Schelhaas
Wageningen UR

In highly managed landscape like the Dutch forests, population dynamics of tree species are regulated by the management strategies of human forest owners. As a consequence these management strategies have a large impact on the total ecosystem. Anticipating climate change forest owners can adapt their management strategies in order to meet their management objectives. The impact that these changes in climate and management have on the forest ecosystems is determined by the actual climate and the extent to which climate change was anticipated. Here we present the results of 100 year scenario evaluations for a forest area in the South-East Veluwe area. Using simulations of forest development we evaluate the effect of climate change and adaptations in management on the forest ecosystem. This effect can be quite severe with almost complete change in dominating tree species and shifts in structural components.

6. Microevolution of trees and climate change. A simulation study bridging eco-physiology and quantitative genetics

Koen Kramer
Wageningen University

Two general misconceptions frequently occur with respect to adaptation of trees to climate change. First, that trees cannot adapt to climate change because the longevity of trees is of the same magnitude as the time frame at which climate change occurs. However, trees reproduce annually from an early age onwards and most selection occurs in de seedling stage rather than at the adult phase. Second, that trees can be treated as monoliths in species area models, without any adaptation to local conditions within the geographic area where the species occurs.

The ForGEM model was developed to accommodate both issues. ForGEM is a classical individual- and process-based model on establishment, growth, competition and mortality of trees. An innovative feature of ForGEM is that a quantitative genetic model can be combined to each of the parameters that determine the ecophysiological processes. Thus, micro-evolutionary adaptation to local and changing environmental conditions can be simulated by a change of model parameters based on genetic principles and the consequences thereof on fitness.

The simulation results indicate that adaptation to climate change is possible for important traits as phenology and water use. The rate of the adaptive response to climate change and the consequences on genetic diversity depend on forest management. In absence of forest management the genetic diversity largely remains in the population, however, the rate of adaptive response is low. With increasing management activities, the genetic diversity declines, but the adaptive response increases. New results and on-going developments with the ForGEM model are discussed.

3c: Ecology meets physiology

Conveners: Wilco Verberk (Radboud University Nijmegen)
Ronald Pierik (Utrecht University)

1. Mixotrophs in the food web: Linking physiology to population dynamics

Susanne Wilken, Jolanda M.H. Verspagen, Suzanne Naus-Wiezer, Ellen van Donk, Jef Huisman
Netherlands Institute of Ecology / University of Amsterdam

Mixotrophic organisms combine autotrophic and heterotrophic nutrition. Mixotrophs are increasingly recognized as key components of aquatic microbial food webs, where they compete for nutrients and light with, but also feed on other phytoplankton species. We used mixotrophs to test several key concepts in ecology, such as the Metabolic Theory of Ecology and Intraguild Predation Theory.

The Metabolic Theory of Ecology predicts that heterotrophic processes increase more strongly with temperature than autotrophic processes. This was confirmed by our experiments, which showed that the grazing rate of the mixotrophic chrysophyte *Ochromonas* sp. increased more strongly with temperature than its photosynthetic rate. Hence, mixotrophs become more heterotrophic with rising temperature, which alters their trophic position in aquatic food webs.

The ability of *Ochromonas* to grow autotrophically on ammonium, but not on nitrate, offered a unique opportunity to test Intraguild Predation Theory by manipulating the trophic position of the mixotroph. With ammonium as nitrogen source, *Ochromonas* competes with its autotrophic prey for nitrogen and therefore acts as intraguild predator. With nitrate, *Ochromonas* is not in competition with its prey for nitrogen, but acts solely as predator. Using models and chemostat experiments, we show that intraguild predation enabled *Ochromonas* to suppress its prey (a toxic cyanobacterium) more strongly than would have been possible by predation alone. This indicates that intraguild predation by mixotrophic organisms may open up interesting new possibilities for biological control of microbial pest species.

2. Natural variation in encapsulation ability and hemocyte load in *Drosophila melanogaster*

Sylvia Gerritsma, Ammerins de Haan, Louis van de Zande, Bregje Wertheim
University of Groningen

Natural populations experience a set of conditions in their local environments that are continuously changing. One of the local conditions encompass natural enemies like parasitoids. Parasitoids are insects that use other insects as hosts to lay their eggs, and the developing parasitoid larvae kill their hosts. These parasites are a major source of mortality for many insect species, which has led to strong selection pressures on host resistance. Host-parasitoid interactions vary among geographical regions due to environmental factors and species interactions, creating variation in host immunity among local populations and species. *Drosophila* evolved a cellular immune response to parasitoids that results in melanotic encapsulation of the parasitoid wasp eggs. Previous studies have shown that a clear correlation exists between resistance of the tested *Drosophila* species and their total hemocyte (blood cell) load. Large geographic variation in resistance among natural populations of *D. melanogaster* exists, comparable to the variation found among *Drosophila* species. To test whether a similar correlation as the between species comparison can be found within *D. melanogaster* and to study the microevolutionary processes that created the variation in immune response in an ecological context, we tested the relationship between hemocyte load of field lines collected from natural populations of *D. melanogaster* in Europe and their encapsulation ability. We found substantially different patterns within the *D. melanogaster* species than were found for the between-species comparisons. Our results indicate that the natural variation within *D. melanogaster* in immune function may depend on optimized ratios between the different hemocyte types.

3. Physiological effects of *Varroa destructor* on honey bees

Coby van Dooremalen, Esther Stam, Lonne Gerritsen, Bram Cornelissen, Jozef J. M. van der Steen, Frank van Langevelde, Tjeerd Blacquière
Wageningen UR

Recent elevated winter loss of honey bee colonies is a major concern. The mite *Varroa destructor* in combination with one or more stressors, such as low food availability or chemical toxins, is considered to be one of the main causes for honey bee colony losses. The presence of *V. destructor* places an important pressure on bee health. *V. destructor* shortens the lifespan of individual bees, while long lifespan during winter is a primary requirement to survive until the next spring in temperate regions. We investigated the effects of different levels of *V. destructor* infestation during the transition from short-lived summer bees to long-lived winter bees on the lifespan and physiology of individual bees and the survival of bee colonies during winter. Low *V. destructor* infestation levels before and during the transition to winter bees resulted in an increase in lifespan of bees and higher colony survival compared to colonies that were not treated and that had higher infestation levels. Honey bee lifespan is highly dependent in the protein build up early in life. We examined the protein content and growth of young bees that emerged with and without *V. destructor* infestation, including

the interactive effect of food availability. Both *V. destructor* infestation and reduced pollen availability reduced body weight, abdominal protein level, and increased the head to abdomen protein ratio. The availability of ample pollen did however not result in compensation for reduced mass and protein content caused by *V. destructor* infestation in young bees after one week of their adult life. This study contributes to theory about the multiple causes for the recent elevated colony losses in honey bees.

4. Canopy light cues affect emission of constitutive and methyl jasmonate-induced volatile organic compounds in *Arabidopsis thaliana*

Wouter Kegge, B.T. Weldegergis, R. Soler, M. Vergeer-Van Eijk, M. Dicke, L.A.C.J. Voesenek, R. Pierik
Utrecht University

Dense stands provide an environment for many plant-plant interactions. In these stands, plants can touch neighbouring plants and are likely to perceive a reduction in the ratio between red and far-red light, both cues that can induce the shade avoidance syndrome. Further, volatile organic compound (VOC) mediated information transfer between plants is likely to occur in dense stands, since short inter-plant distances are required for information transfer through volatiles signals. Here, these VOCs function as semiochemicals in plant-plant and plant-insect interactions. The emission of VOCs is induced upon herbivory in (methyl-) jasmonate dependent manner. Natural enemies of plant herbivores can be attracted with VOCs and these VOCs can function within- and between-plants as signaling molecules to prime plants for future attack. However, when plants grow in dense stands, direct defense is negatively affected by competition for light.

Here, we demonstrate that competition for light negatively affects the emission of both constitutive emitted and methyl-jasmonate-induced VOCs in *Arabidopsis thaliana* and that naïve caterpillars of the specialist herbivore *Pieris brassicae* are not able to distinguish between control and MeJA-induced plants when plants are grown in shading conditions. Thereby, we argue that studies on plant-plant and plant-insect interactions through VOCs should take into account the light quality within dense stands when being extrapolated to natural and agricultural field conditions.

5. Self/non-self discrimination in *Potentilla reptans*: interactions between physiological and physical distance?

Bin J.W. Chen, Heinjo J. During, Niels P.R. Anten
Utrecht University

Recent studies suggested that plant roots have the ability to discriminate between self and non-self roots based on the identity of neighbours, and respond differentially. The mechanism behind it seems to be physiological coordination rather than genetically based allochemical recognition, since plants treat connected parts as self while disconnected parts as non-self. We conducted close-self, distant-self and non-self neighbouring scenarios with three genotypes of *Potentilla reptans* clones, rather than single-ramet-pairs. Neither neighbouring scenario nor scenario × genotype interaction had significant effects on the root mass of plants. Only in one genotype, distant-self scenario showed higher aboveground mass than close-self scenario, which was mainly due to the elevated stolon mass. Thus our study did not support the results of previous research which showed more root growth in disconnected ramet-pairs than in intact ramet-pairs, and in distant-originated ramet-pairs than in close-originated ramet-pairs. We were unable to found the evidence of physiological coordination mediated rooting responses to neighbours in *P. reptans*.

6. Effects of drought on species composition and distribution of tropical forests; the underlying mechanisms

Lourens Poorter
Wageningen University

Rainfall and plant water availability are the main drivers of large-scale gradients in species richness, composition and distribution of tropical lowland forests. We use data from 220 1-ha plots in Bolivia, to show that climate is a much more important driver than soils. Results of a comparative dry-down experiment indicate that the ability of tropical tree species to survive prolonged periods of drought is related to drought avoidance (deciduous leaf habit), and water storage in the taproot. For evergreen species drought survival is positively related to wood density and cavitation resistance. Using an ecophysiological model, we show that species' functional traits shape the whole-plant water compensation point. Species variation in water compensation point allows for local coexistence in a tropical dry forest, and predicts species distribution across large-scale gradients in water availability. Future climate change and increased drought may therefore have local effects on species coexistence, and regional effects on species distribution.

3d: Disease ecology and Ecological Immunology

Conveners: Jacintha van Dijk (Netherlands Institute of Ecology)
Nienke Hartemink (Utrecht University)

1. Habitat connectivity and other landscape factors in the context of vector-borne diseases

Nienke A. Hartemink, S.O. Vanwambeke
Utrecht University

Land use and landscape structure may have considerable impact on the dynamics of infectious diseases, especially zoonotic and vector-borne diseases. In the case of vector-borne diseases, whether or not an infectious pathogen can spread in a certain area will depend largely on whether the vectors and/or host species can circulate or not. This, in turn, will be determined for many species by the connectivity of the habitat. In a recent review on the interactions between landscape, humans, vectors and hosts, several case studies show that habitat connectivity is an important determinant of disease risk. Habitat connectivity is a concept often used in the context of species conservation and species survival. In epidemiology, it has been used less frequently. Still, in the context of epidemiology of vector-borne diseases, it may be very important. However, notwithstanding the importance of the concept, there is no generally accepted and employed formal definition of connectivity and many different measures for connectivity have been applied in the various research fields. Also, the relations between habitat fragmentation, habitat connectivity and the spread and occurrence of vector-borne diseases are not straightforward. In this study, we try to use insights obtained in the field of landscape ecology, metapopulation theory and infectious disease epidemics to come up with lessons for the field of vector-borne disease studies. Also, we will discuss the relation between habitat fragmentation, habitat connectivity and the spread and occurrence of vector-borne diseases and show how these relationships work in several examples in the literature. We focus on disease under study in the EDENext project: mosquito-borne diseases, tick-borne diseases, rodent-borne diseases, sandfly-borne diseases and midge-borne disease.

2. Timing and effect of influenza A virus outbreaks in breeding colonies of Black-headed gulls

Josanne H. Verhagen, F. Majoor, P. Lexmond, O. Vuong, R.A.M. Fouchier, T. Kuiken
Erasmus Medical Centre, Rotterdam

Investigating diseases in wildlife populations is a challenge, as wild animals are difficult to (re)capture and tests specific for the sampled wildlife species often do not exist. Here, we describe spatial and temporal dynamics of avian influenza A virus infections in 7927 free-living Black-headed gulls sampled in the Netherlands from 2006 to 2010. Annual outbreaks were detected on breeding colony sites that appeared to be limited to hatch-year gulls. The viruses were characterized as H13 and H16 low pathogenic avian influenza viruses (LPAIV). To investigate the timing and effect of these outbreaks, biometric measurements were collected from 874 alive hatch year gulls. In addition, timing of infection was estimated based on the number of hatchlings and fledglings in time that were monitored using enclosures surrounding multiple nests. Hatch-year gulls became infected shortly after fledging. Several factors could explain the timing of infection, such as changes in behavior, movement, physiology and/or immunology. Hatch-year gulls became infected when average relative bodyweight decreased, but no significant differences in relative bodyweight were shown between gulls sampled on the same location and day, suggesting LPAIV caused no or very mild disease.

To conclude, here we describe annual outbreaks of LPAIV in Black-headed gulls on the breeding colony sites directly after fledging and our results suggest LPAIV cause no or very mild disease in hatch year Black-headed gulls.

3. Walking with insects: how baculoviruses manipulate caterpillar behaviour

Stineke van Houte, V.I.D. Ros, J.M. Vlak, M.M. van Oers
Wageningen University

Many parasites alter host behaviour to the chance of transmission. Examples of behavioural manipulation are accumulating, covering a broad spectrum of parasites and hosts. Surprisingly little is known on the underlying molecular mechanisms. A typical case of behavioural manipulation is found in insects infected with baculoviruses. Infected caterpillars show hyperactive behaviour and climb to plant tops or the forest canopy (‘tree top disease’). Larvae die at elevated positions, which is thought to promote dissemination of the virus to lower foliage. Recently, the *egt* gene from the baculovirus *Lymantria dispar* multiple nucleopolyhedrovirus (LdMNPV) was identified to induce tree top disease in *Lymantria dispar* larvae. We studied the effect of *Autographa californica* multiple nucleopolyhedrovirus (AcMNPV) on climbing behaviour in two different host insects, the cabbage looper *Trichoplusia ni* and the beet armyworm *Spodoptera exigua*. We show that the effect of this virus on caterpillar behaviour differs between these two host species, and dispute the role of the *egt* gene in inducing tree top disease.

4. Effects of the invasive Pacific Oyster on native pathogen-host systems in the Wadden Sea

Anoek Goedknegt, D. Thieltges
Netherlands Institute for Sea Research

When invasive species enter a new ecosystem they can affect native species in a variety of ways. For example, in their new habitat invasive species often lack natural enemies like predators and pathogens (*enemy release hypothesis*), giving them a competitive advantage over native species. At the same time, the risk for native species can become even higher as invaders can co-introduce pathogens. These new pathogens may infect native hosts and cause severe disease problems for native populations (*spill-over effect*). In turn, the invader can also serve as a new host for native pathogens, thereby increasing the number of potential hosts and consequently making it easier for the pathogen to spread and increase in native host (*spill-back effect*). In this presentation, the interplay of these effects is explained by using the most prominent invader in the Wadden Sea, the Pacific oyster (*Crassostrea gigas*), as an example. This bivalve was imported to Europe for aquaculture and has spread via the Oosterschelde over the entire Wadden Sea during recent years.

5. How does a free-living bird stay healthy year-round? Trade-offs and disease risk result in complex patterns of immune function

Arne Hegemann, K.D. Matson, B.I. Tieleman
University of Groningen

A central hypothesis of eco-immunology is that immune defences are traded off against competing physiological and behavioural processes. Additionally, selective pressures exerted by pathogens and parasites are expected to shape these trade-offs. Consequently, immune indices are expected to vary during the annual cycle. Yet, only few studies have investigated variation in multiple immune indices over an entire annual cycle of free-living birds. We quantified baseline and induced immune function in free-living Skylarks *Alauda arvensis* throughout the whole annual cycle. Because Skylarks undergo characteristic and predictable changes in the ecology during the annual cycle, we expected clear seasonal variation in immune function as a result of trade-offs and variation in disease risk. We found significant variation among annual-cycle stages for an array of baseline immune patterns and this seasonal variation differed between years. However, the ability of birds to mount a costly immune response, which we quantified via changes in 14 physiological parameters, was constant among annual-cycle stages. Based on these results, we developed a conceptual model how skylarks (and birds in general) stay healthy throughout the year. We suggest that the variability in baseline immune defences results from trade-offs between annual-cycle activities, food availability and parasite & pathogen pressure. In contrast, the sickness response mounted when a pathogen established itself in the body, is sufficiently important that skylarks cannot trade this response off against other life-history demands. Ultimately, this framework will help understanding patterns of individual susceptibility to diseases.

6. Describe microbial communities associated with eggs to comprehend avian immune system

Stéphanie Grizard, K. Matson, F. Dini-Andreote, B.I. Tieleman, J.F. Salles
University of Groningen

Immune function of birds is often explained by, or related to, the microbial pressure posed by the environment. It is thus necessary to develop an independent measure of this potential disease risk. Eggs provide us a simplified model system to study immune protection against microbes. Indeed, the consequences of the interactions between microorganisms and eggs for fitness are of great relevance (e.g. on hatching success). However, despite the increasing interest in studying the microbial assemblages associated with eggs, most approaches applied so far relied on culture-dependent methods. We have characterized the size and the structure of bacterial and fungal communities, using culture-independent techniques. We used PCR-DGGE, qPCR and clone libraries on semi-captive birds (Pigeons *Columbia livia*). We observed that incubation time lead to dramatic changes in microbial communities. Especially for bacteria, we observed a change in community structure, a reduction in diversity and a two-fold increase in abundance. We have expanded the use of these techniques to free-living house sparrows (*Passer domesticus*), and described the communities associated with freshly laid eggs. More generally, we aim to couple these molecular tools with the measure of antimicrobial defense proteins present in the albumen. The combination of microbial and immunological tools should help understanding how immune index variations are concomitant with microbial pressure under different environments, and thus can be applied in field studies of wild birds.

Session 4

4a: Microbial ecology - From species richness to functional biodiversity

Conveners: Anne Daebeler (Netherlands Institute of Ecology)
Sascha Krause (Netherlands Institute of Ecology)
Bjorn Robroek (Utrecht University)

1. Microbial transformations of nitrogen, sulfur and iron dictate vegetation composition in wetlands: an overview

Leon P.M. Lamers, Josepha M.H. van Diggelen, Huub J.M. Op den Camp, Eric J.W. Visser, Esther C.H.E.T. Lucassen, Melanie A. Vile, Mike S.M. Jetten, Alfons J.P. Smolders, Jan G.M. Roelofs
Radboud University Nijmegen

The majority of studies on rhizospheric interactions between microbial communities and vegetation focus on pathogens, mycorrhizal symbiosis, and/or carbon transformations. Although the biogeochemical transformations of nitrogen (N), sulfur (S) and iron (Fe) have profound effects on plants, these effects have received far less attention.

Firstly, all three elements are plant nutrients, and microbial activity significantly changes their mobility and availability. Secondly, microbial oxidation with oxygen supplied by radial oxygen loss (ROL) from roots in wetlands causes acidification, while reduction using alternative electron acceptors leads to generation of alkalinity, affecting pH in the rhizosphere and hence plant composition. Thirdly, reduced species of all three elements may become phytotoxic. In addition, Fe cycling is tightly linked to that of S and phosphorus (P). As water level fluctuations are very common in wetlands, rapid changes in the availability of oxygen and alternative terminal electron acceptors will result in strong changes in the prevalent microbial redox reactions, with significant effects on plant growth.

Depending on geological and hydrological settings, these interacting microbial transformations change the conditions and resource availability for plants, which are both strong drivers of vegetation development and composition by changing relative competitive strengths. Conversely, microbial composition is strongly driven by vegetation composition.

Therefore, the combination of microbiological and plant ecological knowledge is essential to understand the biogeochemical and biological key factors driving heterogeneity and total (i.e., microorganisms and vegetation) community composition at different spatial and temporal scales. As N and S inputs have drastically increased due to anthropogenic forcing and Fe inputs have decreased at a global scale, this combined approach has become even more urgent. This paper will include a call for transdisciplinary research by providing a number of challenging topics for future research.

2. The Role of Diversity and Traits in Methane Cycling in Wetlands: a model for conceptualizing microbial life strategies

Paul L.E. Bodelier
Netherlands Institute of Ecology

The anomalies in atmospheric methane concentrations in late twentieth century, including the renewed increase since 2007 have been proposed to be caused by changes in (microbial) methane cycling in wetland ecosystems. Although microbial processes are fundamental to methane emission from wetlands, the diversity of microbial communities and traits of the microbes involved are not taking into consideration in assessing potential sources of variation in the global methane budget. Production of methane by methanogenic archaea in wetlands is a major source while consumption by methane oxidizing bacteria in these ecosystems is a major sink. There are many environmental factors that control these processes, which have also been extensively investigated. The advent of a multitude of culture independent techniques has resulted in a glimpse of the possible role of microbial community composition and or response in methane cycling reactions. Especially, the combined use of molecular biological techniques with the application of stable isotopes has led to valuable insight into the link between microbial characteristics and biogeochemical processes. Stable isotope probing studies targeting RNA, DNA, lipids and proteins demonstrate that in ecosystems important for global methane cycling only a limited number of species is responsible for production and consumption of methane. The limited functional-diversity combined with the tracking of the active species enables the assignment of life strategies to methane processing bacteria, conceptualizing their traits and ecological characteristics. We will propose a life-strategy concept which may have application for microbial ecology in general.

3. **Temporal dynamics of archaeal ammonia oxidizers in agricultural soil in response to different environmental parameters**

Michele C. Pereira e Silva, Brigitte Schloter-Hai, Franck Poly, Nadine Guillaumaud, Michael Schloter, Jan Dirk van Elsas, Joana Falcão Salles
University of Groningen

In this study we determined the abundance and diversity of AOA in four agricultural soils during the growing season in 2010 using the functional gene amoA as marker. We also measured relevant chemical soil parameters and potential nitrification activity (NEA). Rates of NEA were significantly correlated to amoA gene abundance at all times, being significantly lower in soils with low pH and clay content. To further understand the changes in community composition, we performed a barcoded pyrosequencing based on amoA. The AOA communities were found to be highly dynamic, with changes in community composition varying between 50% and 72% over time. The diversity estimates as well as the number of OTUs observed were higher in the soils with lower pH. In order to determine the extent to which genetic diversity could explain community functioning, we calculated a series of diversity measures based on OTUs. The average phylogenetic distance between OTUs was significant and positive correlated to the variation in the community functioning (r2 = 0.38), indicating that more divergent communities were more productive. This percentage of variation increased (r2 = 0.65) when using the Rao's index, taking into account both OTU distance and abundance. We also observed negative correlations between NEA and Shannon index or OTU richness, indicating that the most productive communities were dominated by few types. These results suggest that phylogenetic metrics based on the amoA gene can be used to predict changes in ammonia oxidation. Moreover they indicate that few phylogenetically distant and abundant AOA-affiliated types are likely the responsible for NEA rates in these agricultural soils.

4. **First kingdom-wide fungal diversity assessment in the Andean cloud forests reveals strong community structuring among forest types along an altitudinal gradient**

József Geml, Nicolás Pastor, Alejandra G. Becerra, Silvia Pacheco, Christian Y. Wicaksono, Eduardo R. Nouhra
Naturalis Biodiversity Center

The Yungas, a system of subtropical montane forests on the eastern slopes of the Andes, are both extremely diverse and severely threatened by anthropogenic pressure and climate change. Although the flora and fauna of the Yungas have been extensively studied, fungal diversity in this unique ecoregion has remained practically unknown. We carried out massively parallel pyrosequencing of ITS rDNA from soil samples taken in Calilegua National Park, in Jujuy province, Argentina. Nine sites were sampled, representing the three major forest types along an altitudinal gradient: the piedmont forest (400–700 m asl), the montane forest (700–1500 m asl), and the montane cloud forest (1500–3000 m asl). Using a 97% similarity cut-off value, we delimited 1693 and 1933 fungal non-singleton operational taxonomic units (OTUs) in the ITS1 and ITS2 datasets, respectively, with almost 50% of these identified to species and additional ca. 20% to genera. Although OTU richness values were comparable across sites, the NMDS analyses of the ITS1 and ITS2 datasets concordantly suggested that fungal communities were significantly different among the forest types, with many OTUs showing strong habitat preference for a certain altitudinal zone. Beside elevation, soil pH, soil Nitrogen and organic matter contents, and C:N ratio strongly correlated with fungal community structure as well, although these variables were also correlated to the forest type. Our data offers an unprecedented insight into the fungal biodiversity of the Yungas and into the changes in fungal community structure along an altitudinal gradient, with potential applications in conservation strategies to preserve the unique biodiversity of the Andean forests.

5. **Snow cover manipulation effects on microbial community structure and soil chemistry in a mountain bog**

Amber Heijboer
Wageningen University

Alterations in snow cover driven by climate change may impact ecosystem functioning, including biogeochemistry and soil (microbial) processes. We elucidated the effects of snow cover manipulation (SCM) on above-and belowground processes in a temperate peatland. In a Swiss mountain-peatland we manipulated snow cover (addition, removal and control), and assessed the effects on *Andromeda polifolia* root enzyme activity, soil microbial community structure, and leaf tissue and soil biogeochemistry. Reduced snow cover produced warmer soils in our experiment while increased snow cover kept soil temperatures close-to-freezing. SCM had a major influence on the microbial community, and prolonged 'close-to-freezing' temperatures caused a shift in microbial communities toward fungal dominance. Soil temperature largely explained soil microbial structure, while other descriptors such as root enzyme activity and pore-water chemistry interacted less with the soil microbial communities. We envisage that SCM-driven changes in the microbial community composition could lead to substantial changes in trophic fluxes and associated ecosystem processes. Hence, we need to improve our understanding on the impact of frost and freeze-thaw cycles on the

microbial food web and its implications for peatland ecosystem processes in a changing climate; in particular for the fate of the sequestered carbon.

6. The stability and variability of intestinal microbial diversity across healthy human population

Leo Lahti, Jarkko Salojärvi, Anne Salonen, Marten Scheffer, Willem M. de Vos
University of Helsinki, Finland / Wageningen University

Diverse microbial communities colonize our body rapidly after birth, establishing robust ecosystems within our bodies during the first years of life. A particularly rich microbial community is found in the gastrointestinal tract where up to a thousand distinct bacterial phylotypes and a trillion bacterial cells per gram can be encountered in a healthy adult individual. These communities form a virtual metabolic organ that interacts with the human host and has a profound impact on our well-being through its central role in nutrition, immune system, and other bodily functions. The functional potential of the intestinal ecosystem is determined by its overall phylotype composition which is associated with and in some cases causally related to health.

Recent accumulation of high-throughput phylotype profiling data sets is now for the first time enabling global characterization of the overall variability of microbial communities in the human intestine. In particular, computational analysis with the Human Intestinal Tract chip (HITChip), a phylogenetic microarray has enabled standardized data collection of over one thousand gut-specific bacterial phylotypes including many less abundant species that cannot be cultivated in a laboratory, and whose functional role is less well known.

Integration of standardized phylogenetic profiling data of a thousand phylotypes across a thousand human individuals from over ten countries scales up the current analyses by an order of magnitude, revealing huge inter-individual variability in microbial diversity across human population as well as alternative stable ecosystem states that are associated with environmental and phenotypic factors such as ageing, overweight, and health status. We will discuss how these recent observations provide new insights into the role of our co-evolved microbial partners in health and well-being, as well as guidance for the design and interpretation of future studies.

4b: Integration of population genetics, dynamics and social structure

Conveners: Arjen de Groot (Wageningen UR)
Eelke Jongejans (Radboud University Nijmegen)

1. Non-invasive genetic monitoring reveals spatiotemporal variation in social, demographic and genetic structure

Arjen de Groot, Hugh Jansman, Dennis Lammertsma, Hans-Peter Koelewijn, Loek Kuiters
Wageningen UR

Our knowledge of the dynamics of natural wildlife populations is still limited, for various reasons. Demographic and genetic structure are strongly affected by fluctuating circumstances, as well as by social interactions among individuals. Understanding the interplay between social, demographic and genetic structure therefore requires simultaneous monitoring of each of these aspects over long time periods. Yet, traditional study methods are often hampered by practical constraints: individuals may be hard to recognize or track in the field, and methods may cause unwanted disturbances. Genetic profiling of non-invasively collected samples (e.g. faeces, hairs) can be a solution, as besides population genetic data it also yields data on population size, survival, reproductive success, mating patterns and spatial distribution. Since 2002, we applied non-invasive genetic monitoring to study a reintroduced population of Eurasian otters (*Lutra lutra*). Based on yearly collection of faecal samples, we were able to build a pedigree of the population, and to locate territories of individual animals. Here, we will show how this helped us to learn how social interactions, such as male dominance, may result in skewed survival and mating success, and how this affects the genetic viability of the population. We could show that levels of relatedness and inbreeding are rapidly increasing, even though genetic diversity and heterozygosity are still fairly high. This type of monitoring is essential for early detection of inbreeding risks, and may also shed new light on natural mechanisms for inbreeding prevention in mustelids.

2. Population dynamics of *Arabidopsis lyrata* ssp. *petraea* across its range explained by environmental variation

Philippine Vergeer, Eelke Jongejans, William E. Kunin
University of Leeds / Radboud University Nijmegen

For plants with wide distribution areas that cover a wide range of ecologically distinct habitats, evolutionary divergence can lead to substantial phenotypic variation across a species' range. These intraspecific trait differences can be very informative about the nature of the selective environment as they potentially reflect different environmental selection pressures while controlling for other species characteristics.

In this study, 36 populations of the perennial plant *Arabidopsis lyrata* were analysed across its northwest European range. Integral projection models were used to examine if different environments across a distribution range have resulted in different selection pressures, and if these different selection pressures explain the differences in life history and population performance.

Strong differences in life history strategy were found which could largely be explained by the different environmental and climatic conditions faced by these populations. We then analysed the persistence of the different populations by projecting different global change scenarios. A decline in population growth rate with future climate change was predicted for most populations. In particular populations in the southern range margins were predicted to be highly vulnerable to clime change, this in contrast to populations in the northern regions that were expected to show high resilience to future climate change. These data suggest that climate change may cause a northward distribution shift of this species.

3. Partitioning genetic variation into independent spatial and ecological components

Patrick G. Meirmans, Oscar Gaggiotti
University of Amsterdam

The geographic distribution of genetic variation is determined by various processes such as migration, selection, drift, and various other historical, spatial, ecological and demographic processes. Studying these processes is important for our understanding of the evolution of biodiversity, but also has applications in evolutionary biology, conservation, forensics, and plant and animal breeding. However, quantifying the relative contribution of these processes has proven very difficult. One problem is that selective processes such as adaptation to climatic factors can result in gradients in genetic variation that are similar to spatial patterns that derive from neutral processes such as isolation by distance. Here, we present a new method that allows to tease apart the effects of different spatial processes on genetic variation and quantify their relative contributions as well as their overlap. These relative contributions can then be expressed in terms of the widely used summary statistic F_{st}. This allows a direct connection between the method and standard population genetic theory. We illustrate the method at the hand of two genome wide SNP-data sets. The first data set is from North-American Balsam poplar where we show that the most important fraction of among population differentiation is related to genomic incompatibilities rather than adaptation to

climatic variables. The second dataset is from humans in African where we show that cultural aspects explain more of the genetic variation than climatic adaptation.

4. Effect of habitat suitability and connectivity on adaptation, inbreeding and metapopulation viability

Peter van Tienderen, Gerard Oostermeijer, Patrick Meirmans
University of Amsterdam

For many species the suitability of habitats changes in time and in space. For instance, habitats may become less (or more) suitable in time due to succession, or in space along a gradient from the centre towards the margin of a species' distribution. This has an impact on many aspects of population genetics and demography. Local population densities may change, and hence the amount of genetic variation, in turn affecting the adaptive potential of local populations and level of inbreeding depression. Local populations may become extinct die to stochastic processes that become more important if conditions deteriorate. Empty sites affect the connectivity of populations and hence colonisation rates as well as presence of enemies (pests, pathogens) and allies (pollinators).

We will use *Liparis loesilli* as an example to illustrate the various processes and their interaction, and what key factors were identified for persistence of the species at a meta scale. Moreover, we present some theoretical expectations on the how demographic and genetic processes interact along gradients of habitat suitability, focusing on (i) the adaptive potential in systems with transient populations and source-sink relationships, (ii) population structure at the genetic and demographic level, and finally, (iii) what factors determine the rate by which species contract or expand in range in a changing world.

5. Surviving in a cosexual world: dioecy as a reproductive strategy

Marjolein Bruijning, Marco D. Visser, Eelke Jongejans, Helene C. Muller-Landau, S. Joe Wright
Radboud University Nijmegen

Dioecy as a breeding system in flowering plants is rare compared to other breeding systems although it has evolved many times independently. Dioecious populations contain less seed producing individuals than hermaphroditic populations, for equal population sizes, and this is predicted to reduce population fitness. To be able to coexist with non-dioecious species, dioecious species must have compensatory fitness advantages to compensate for the predicted cost. What these benefits of dioecy are is an intriguing and longstanding question in ecology. The aim of this study was to evaluate different hypothesized benefits, while focusing on multiple traits and life stages. We collected gender information of almost 3000 individuals of eight dioecious species on Barro Colorado Island (Panama). These data were combined with long-term demographic data from the 50-ha FDP. In order to evaluate the consequences of dioecy, the costs and benefits of dioecy were quantified in terms of population growth rate, which is a proxy for population fitness. Integral Projection Models (IPM's) were built for eight dioecious species and eight hermaphrodite species to predict the population growth rate (λ) of the species. For all studied species, λ was close to 1, indicating stable populations. These IPM's were used to perform multiple simulations to quantify the costs and benefits of dioecy, and to calculate the contribution of different life stages to λ. It is generally suggested that dioecious females may benefit from resource allocation towards reproduction, due to the loss of male functions. This idea is supported by our results, as we found that dioecious species have an increased fecundity (on average 33%; estimated by inverse modeling techniques), compared to hermaphrodite species, while correcting for seed mass. Although adult survival contributed most to λ in all species, differences in fecundity between dioecious and hermaphrodite species are suggested to be important on the long-term, in compensating for the predicted fitness cost of being dioecious. This study is the first that evaluates the fitness consequences of dioecy at the level of the entire life cycle, thereby including different life stages and taking into account tradeoffs.

6. Colourful mites: the effects of environmental noise on the population dynamics of selectively harvested populations

Hedwig Ens
Imperial College London, UK / University of Amsterdam

Population management requires predicting population dynamics, which requires understanding the underlying processes. It is known that important factors in governing population dynamics are the internal population dynamics and the environmental state/variability. Temporal autocorrelation in environmental variation can be described using colours: red (positive autocorrelation, slow fluctuations), white (no autocorrelation, uncorrelated fluctuations), and blue (negative autocorrelation, rapid fluctuations) noise. It is unknown to what extend population dynamics are tinged by environmental noise, and what the effect of perturbations (e.g. harvesting) on this interplay is. A question becoming more important as climatic variables are shown to be changing colour. Using the bulb mite *Rhizoglyphus robini* as a model system, a controlled laboratory experiment investigated the effects of noise colour on selectively harvested populations. It was

shown that environmental forcing and size-selective harvesting can change the population dynamics of stage-structured populations. Different life stages respond differently to the single perturbations, and the interaction effect cannot be predicted by knowledge on the effects of the single perturbations. It is argued that taking into account (st)age structure is of critical importance when making predictions on the effect of perturbations and environmental variability on population characteristics.

4c: Biodiversity and conservation in a spatial context

Conveners: Kees Musters (Leiden University)
Marije Kuiper (Wageningen University)

1. Biodiversity and conservation in a spatial context

Kees C.J.M. Musters
Leiden University

It is well known that local ecological patterns and processes are strongly affected by landscape patterns and processes. However, for effective conservation management, specific knowledge is needed. We need to know how these landscape patterns and processes exactly work at specific locations. We need that to be able to take the landscape context into consideration in local management decisions. But we also need that to be able to take local biodiversity into consideration in landscape conservation management decisions.

Recently, a set of eight hypotheses was formulated on landscape moderation of biodiversity. All these hypotheses are relevant for conservation. But the importance of temporal aspects has got little attention up to now. And yet conservation might need long term continuation to be effective. This asks for long term commitment of the people involved. Studies of commitment suggest that the spatial context may also be crucial for long term motivation.

2. Biodiversity sources or diaspore sinks: stream restoration in a fragmented landscape

Rob G.A. Fraaije, Leonieke B.S. Breeman, Jos T.A. Verhoeven & Merel B. Soons
Utrecht University

Riparian zones are potential hotspots for species diversity, but a severe loss of biodiversity occurred along many European lowland streams because of channelization and habitat degradation. Stream restoration projects aim at counteracting this loss by restoring a natural hydrology, but many projects fail in the return to high species richness. Dispersal limitation may constrain species colonization at these often spatially fragmented projects. Stepping-stone habitats could increase connectivity, but for many restoration projects this function is disabled because of an insufficiently restored hydrology. At the same time, improving restoration proves difficult with complex hydrologic conditions. The goal of this study was to get a better understanding of successful restoration by assessing the colonization of 17 riparian plant species in field experiments at three stream restoration projects in the Netherlands. Seeds and seedlings were placed along transects perpendicular to a stream in the riparian zone. Germination and seedling survival was determined for three months. Along each transect, soil moisture content, groundwater level and surface water level were measured hourly. Permanent flooding showed a clear negative impact on germination and seedling survival of all species. A positive correlation of species-specific optima for germination and seedling survival with species Ellenberg values for moisture, showed that both processes determine species distribution along moisture gradients. Hence, hydrological heterogeneity provides a range in species-specific optima for germination and seedling survival. This is crucial for successful restoration and a higher biodiversity.

3. Spatiotemporal interactions between agri-environment schemes and nature reserves

William F.A. van Dijk, André P. Schaffers, Jasper van Ruijven, Frank Berendse, Geert R. de Snoo
Wageningen University

In the Netherlands, many of the Agri-environmental schemes (AES) aim at the conservation of valuable plant species in ditch banks. We investigated the effects of AES on ditch bank plant species in the Western Peat District of the Netherlands, using a large dataset of plants monitored by 377 farmers during a 10-year period in 2597 kilometers of ditch bank. No effect of the duration of management was found on the number of target species on which the management focuses. However, the nitrogen demand of the vegetation increased, suggesting that the on-going measures prescribed by AES are not able to decrease soil fertility in ditch banks. Species with a lack of capacity to disperse over long distances showed negative trends over time, while species that disperse by water were increasing. In nature reserves in the same area we found similar trends among these two dispersal groups.

4. Core areas for meadow birds require clear choices

Dick Melman, Henk Sierdsema, Wolf Teunissen, Eddy Wymenga, Leo Bruinzeel, Alex Schotman
Wageningen UR

The unfavourable conservation status of meadow birds in the Netherlands is of serious concern for authorities and conservation bodies. Since 1975 efforts have been directed towards conserving all meadow bird populations nationwide. This approach of spreading the efforts did not reverse the negative trend and at best the investments succeeded in slowing the decline. In order to achieve a turning point, the concept of designating core meadow bird areas has been launched. This idea follows directly from patterns observed in the field in which meadow birds increasingly tend to concentrate in 171high quality areas. The core meadow bird approach, and the tools necessary to

assign and maintain these, stresses that significant progress in conservation can only be achieved with increased efforts in a smaller area. This approach follows partly from the fact that a considerable rise in budgets labelled for meadow bird conservation is currently not realistic. What can be expected of these meadow bird core areas? And what are the associated implications? In this presentation we focus on the black-tailed godwit, the flagship species of the Dutch meadow bird community and a model species for which detailed ecological and demographic data is available. However, possible consequences for other species are touched upon. The core area approach may be applied to other species as a scientific base for nature conservation. A possible consequence of core areas is a change in involvement of and support by the public and agrarians who perform an important role in the current agri-environmental schemes.

5. An experiment to test a novel economic agri-environment scheme

Almut E. Schlaich, Raymond H.G. Klaassen, Ben J. Koks, Willem Bouten, Christiaan Both
Dutch Montagu's Harrier Foundation / University of Groningen

Farmland breeding bird populations have declined dramatically throughout Europe during the last decades due to agricultural intensification. Agri-environment schemes (AES) are widely used to conserve biodiversity in agricultural ecosystems. However, such measures are controversial, because their effectiveness is often not monitored and because they are expensive. Here we introduce a new form of AES, called 'birdfields', which consist of strips with cereals and herbs (sawn with a mixture normally used for field margins) alternated with strips of alfalfa. Alfalfa strips are mown two times during the breeding season. The novelty of birdfields is that part of their financing is covered by the yield of alfalfa. Additionally, mowing events provide food for breeding Montagu´s Harriers Circus pygarus, our target species, by making voles, their main prey, accessible. In 2011, two 20 ha-birdfields were created in the Vriescheloërvennen, East-Groningen. During summer 2012 we monitored the use of these fields by Montagu's Harriers. Vole abundance was monitored by counting burrows along transects. The birdfields were used extensively by Montagu's Harriers breeding in the vicinity of these fields, as shown by harriers tracked by UvA-BiTS GPS-loggers. In addition, the harriers strongly responded to mowing events, demonstrating that prey availability is more important than prey abundance. Apart from Montagu's Harriers many other birds, both during breeding and wintering, used the birdfields. This pilot study shows that birdfields are an effective novel AES. However, it is unknown whether such spatial concentration of agri-environmental measurements is preferable over a more dispersed arrangement.

6. Nature Conservation meets Video Game Technology: a real-time 3D landscape reconstruction of pristine Mauritius

Bodo Schütze, Erik J. de Boer, Henry Hooghiemstra, F.B. Vincent Florens, Claudia Báider, William F. Laurance
University of Amsterdam

With a growing understanding of the vulnerability of earth's ecosystems comes the task to communicate scientific insights to a larger audience. Here we show the use of video game technology to build a fully explorable and potentially interactive real-time visualization of pristine environments in the small oceanic island of Mauritius, Indian Ocean. A digital geographical elevation map, documentary information of the modern vegetation distribution, and pollen-based information for past vegetation distributions are used in combination with procedural, rule-based methods, complemented with classical modeling and painting. We produced a realistic look of modern potential vegetation and surface materials integrated within a real-time 3D game engine. This allows exploration of the virtual world and interaction with selected aspects. The presented methods are powerful tools to create a broad awareness for science, nature conservation, and the consequences of human interference with our fragile environment. This new methodology can find applications in musea (where the visitor can interact with extinct or endangered life forms and learn about them in a playful easy way), scientific research (to improve spatial reconstructions), as well as in applied research (e.g. scenario studies in dune protection and reforestation projects).

4d: Recent advances in paleo-ecology; relations between vegetation and environment

Conveners: Martin Wassen (Utrecht University)
Stefan Dekker (Utrecht University)
Friederike Wagner-Cremer (Utrecht University)

1. Optimization of stomatal densities and vein densities in leafs on evolutionary and contemporary time scales

Martin J. Wassen, Hugo J. de Boer, Maarten B. Eppinga, Rike Wagner-Cremer, Stefan C. Dekker
Utrecht University

Plant physiological adaptation to global changes in atmospheric CO_2 is identified as a crucial climatic forcing. To optimize functioning under rising/falling CO_2, plants reduce/increase the diffusive stomatal conductance of their leaves dynamically by closing stomata and structurally by growing leaves with altered stomatal densities and pore sizes. Uptake for photosynthesis is intrinsically linked to transpirative water loss through the stomatal pores. We show that natural selection has favored those species with most plastic stomatal traits and vein densities capable of optimizing photosynthesis with minimal water stress. Our approach consists of a combination of analysis of fossil data and herbarium samples with modeling. The models reproduce observed stomatal adaptations and vein densities. The models indicate that current adaptation of stomatal densities will continue beyond double CO_2 and predict that doubling today's CO_2 will decrease the annual transpiration flux of subtropical vegetation in Florida by ca 30% potentially altering the freshwater cycle and climate.

Secondly, our models show that the veins of angiosperm leaves had become so densely packed with falling CO_2 during Cretaceous that the vein endings were closer to the stomata than to chlorophyll. This novel design opened the door to a new strategy, in which many small stomata could be employed to take up CO_2 with minimum water loss. From this point onward, more efficient angiosperms could outgrow conifers, offering a new explanation for Darwin's abominable mystery i.e. the rapid rise of deciduous trees during the Cretaceous. Our approach of paleo-ecology and modeling reveal relations between vegetation and the carbon and water cycle and enable us to better understand vegetation – environment feedbacks.

2. Paleo-ecology meets ecology: high-resolution pollen records show rapid climate-forced and system-driven change

Henry Hooghiemstra, Zaire González-Carranza, César Velásquez-Ruiz, Giovanni Bogotá-Angel, Mirella Groot
University of Amsterdam

Observational records from ecologists are 'detailed & short' while records of pollen-based reconstructions are 'blunt & spanning long periods of time'. Bringing together both types of records of ecological change is one of the current challenges. Here we present new pollen records from the tropical Andes showing ecological change at 25-yr resolution over the last 14 kyr (lake La Cocha: González-Carranza et al., The Holocene 22(2012), 1223-1237), 60-yr resolution over the last 2 glacial-interglacial cycles, the last 284 kyr (lake Fúquene: Groot et al., Climate of the Past 7(2011), 299-316), and 125-yr resolution over the last 17 kyr (mire Llano Grande: Velásquez-Ruiz & Hooghiemstra, Review of Palaeobotany and Palynology, in review). Three of the most salient new observations will be discussed. (1) The rapid and frequent changes of altitudinal forest reorganisations are indicative of regular temperature changes from 3-4°/100 yr, with extremes to 10°C/100 yr showing that rapid temperature change is not limited to high latitude areas (Greenland) but is also within the variability of tropical high mountain biomes. (2) The difference between biomes in maximum migration capacity leading at events of rapid climate change to temporarily loss of biomes. The latter has important implications for AD 2100 scenario's as similar levels of temperature increase have been projected. (3) Past environmental change at intraAndean sites appear mainly driven by temperature and atmospheric greenhouse gasses while environmental change at sites located on the Amazonian flank of the Andes are mainly precipitation driven. The differentiation in drivers may cause during the next decades an increasing divergence in ecosystem response.

3. Spring season changes reflected in modern and fossil leaf cuticles

Rike (F.) Wagner-Cremer
Utrecht University

Long term monitoring of leaf development in *Betula nana* has revealed a significant correlation between epidermal cell structure and growing degree days (GDD) in subarctic environments of Northern Scandinavia. The distinct micro-phenological signal is now quantified and serves as modern training set to infer GDD from *B. nana* leaf-remains preserved in peat and lake deposits.

Applied to sub-fossil *B. nana* leaves from northern Scandinavian peat sections, the new methods detects the lengthening of the growing season observed during the past decades and three phases of prolonged growing season since 1750 AD.

Applied to fossil leaf fragments from the Schleinsee (S Germany), ~ 700 – 900 °C GDD for the GI-1e (Bølling) and GI-1c (Allerød) are reconstructed, while estimates for GS-2a and GI-1d do not exceed ~450 – 650 °C GDD. The reconstruction of growing season length parallels the $\delta^{18}O$ profile of the section, showing that mean summer temperature changes are accompanied by an increase in growing season length. Remarkably, the patterns diverge at the transition from the GI-1e to GI-1d, where GDDs fall back to near GS-2a levels before $\delta^{18}O$ summer temperatures decline. This may indicate that seasonality changed before mean summer temperatures were affected by climate change.

4. Using tree rings and isotopes to understand responses of the Amazon basin to climate change: recent advances and pitfalls

Roel J.W.H. Brienen, G. Helle, T.L. Pons, J.L. Guyot, O.L. Phillips, T.R.F. Feldpausch, M. Gloor
University of Leeds, UK

The Amazon basin is one of the largest terrestrial biomass pools and also a major centre of atmospheric convection. In the recent past the forest has acted as a significant carbon sink, but because of its large size, small climatic changes in the basin may significantly alter the carbon balance of the rainforest, and thereby atmospheric [CO2] and the rate of climate change. Understanding how the Amazon rainforest has responded to climate in the past may help predicting future changes. One powerful way to do so is the use of tree rings. We here present recent results on tree ring and carbon and oxygen isotopes records from the Amazon basin. Ring width measurements may provide a useful approach to understand the sensitivity of tree growth to climate, but its use for climate reconstructions seems limited. Carbon isotope ratios in tree rings provide in theory a powerful approach to study physiological responses of trees to increases in atmospheric [CO2] and droughts, but requires careful application. Finally, recent findings on long-term variation in oxygen isotope records from the Amazon basin shows that tree ring cellulose preserved the isotopic composition of precipitation and is a strong proxy for the amount of precipitation over a large area of the catchment. This proxy is also potentially a promising record to detect changes in the hydrological cycle of the basin. We discuss the pros and cons of the different records and how they can be used to improve our understanding of tropical forests to climate change.

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

#	Name	Title
1	Maaike van Agtmaal	Thinking ' inside the box': The Role of Volatile Organic Compounds in Pythium intermedium Suppression
2	Jesus Aguirre	Fit-for-purpose: Species distribution model performance depends on evaluation criteria –Dutch hoverflies as a case study
3	Cassandra van Altena	Stability in food webs: the role of nutritional quality
4	Elisabeth Arvidsson	Individual differences in spatial movement: a large scale exploration test
5	Liesbeth Bakker	Interacting effects of grazing and habitat restoration on the biodiversity and succession of aquatic systems
6	Mara Baudena	A new network technique identifies the climate fingerprint behind woody species richness in Mediterranean forests
7	Carmen van de Beld	Validating candidate genes for parasitoid resistance in Drosophila melanogaster
8	Jim van Belzen	Who is in control? Environmentally induced switches between trophic and non-trophic top-down control
9	Erik de Boer	Rapid ecological change in the oceanic island of Mauritius
10	Mirte Bosse	Analysis of haplotype sharing in different pig breeds and wild boars
11	Tjeerd Bouma	On the role of organism traits in landscape development
12	Maria Briglia	Environmental occurrence versus biodiversity within the anaerobic nitrite-driven methane oxidizing NC10 phylum bacteria
13	Bas Bruning	Symbiotic nitrogen fixation under saline conditions
14	Luc De Bruyn	Host plant patch size and isolation influence the distribution of a monophagous leafminer on *Centaurium erythraea*

#	Name	Title
15	Bin Chen	Self/non-self-discrimination in *Potentilla reptans*: interactions between physiological and physical distance?
16	Roeland Cortois	Negative plant-soil feedback strikes in species rich plant communities, not in monocultures
17	Daniel van Denderen	When does fishing lead to more fish?
18	William van Dijk	Nature reserves and/or ditch bank management
19	Sjoerd Duijns	Functional response curve of Bar-tailed Godwits
20	Gilian van Duijvendijk	Ecology of Ticks, Mice and Lyme Disease
21	Hedwig Ens	Tasty Natives and Nasty Exotics? Tracking differences in invertebrate community on exotic and native plants
22	Karoline Faust	CoNet - a Co-occurrence Network inference tool
23	Joana Frazão	Spatial distribution and dispersal of earthworms in complex landscapes - implications for ecosystem services
24	Yuki Fujita	Why does soil fertility only weakly explain nutrient-related plant traits?
25	Anouk Goedknegt	The invasion of the Pacific Oyster and disease risk for native species
26	Manoj Kumar Gopala Krishnan	Diversity of plant associated bacterial communities from soil in European arctic tundra
27	Laura Govers	Explaining the multi-scale banded seagrass patterns of Shark Bay
28	Abel Gyimesi	Lesser Black-backed Gulls favour junk-food above unpredictable quality-food
29	Amber Heijboer	Linking microbial diversity to the functioning of soil food webs
30	Marloes Hendriks	Roots at work: root responses to soil biota
31	Ruth Howison	Biotically generated vegetation mosaics
32	Zheng Huang	Species' life-history traits explain interspecific variation in reservoir competence
33	Esperanza Huerta	Can arable field margins and non-inversion tillage management stimulate earthworm diversity and density

#	Name	Title
34	Annette Janssen	Multiple states in lake Taihu (China)
35	Jeltje Jouta	Spoonbills as indicator of Wadden Sea ecosystem
36	Roel van Klink	Experimental mowing and soil compaction mimic ecosystem effects of large grazers
37	Andrea Kölzsch	Peeking spring from afar? Predictability of phenology along migration routes
38	Jan Kuiper	Recovery of P from shallow lake ecosystems in the context of alternative stable states; a modelling study
39	Marije Kuiper	The functionality of field margins for skylarks breeding on farmland
40	Leo Lahti	Microbial diversity of the human gastrointestinal tract across healthy adult population
41	Frank van Langevelde	E-Track: From movement tracks to behaviour patterns
42	Jeroen van Leeuwen	The effect of land use type on biological soil quality on semi-arid Crete
43	Quan-Xing Liu	Spatial complexity makes for a more robust mussel bed
44	Wen-Juan Ma	Genetics of vestigialized sexual traits in an asexual wasp
45	Christina May	The effect of developmental nutrition on lifespan, reproduction and gene expression in the fruit fly
46	Angeles Mayor	Feedbacks between vegetation pattern and resource loss enhance degradation potential in drylands
47	Luis Morgado	Biodiversity and habitat partitioning of arctic ectomycorrhizal fungi and their role in vegetation change due to climatic change
48	Elly Morrien	Coupling soil biodiversity to C and N cycling by manipulating soil communities using soil suspension dilutions and stable isotope
49	Sil Nieuwhof	Ecosystem engineering by epibenthic shellfish
50	Jelmer Nijp	Modelling moisture dynamics in the living peat moss canopy
51	Stefanie Nolte	Does livestock grazing influence salt marsh resilience to sea-level rise in the Wadden Sea?

#	Name	Title
52	Keiko Oku	Effects of male ejaculate on female performance in the sorghum plant bug *Stenotus rubrovittatus* (*Hemiptera: Miridae*)
53	Astra Ooms	Linking traits of plants and macro-detritivores to ecosystem services
54	Hélène de Paoli	Importance of self-organisation in the persistence of new-settled mussel beds in the Wadden Sea.
55	Anne Piliere	Responses of freshwater fish and invertebrates to multiple environmental factors: a comparison using Boosted Regression Trees
56	Erica van Rooij	To sing or not to sing: how neighbours affect singing activity in the Great Tit (*Parus major*)
57	Max-Bernhard Rudnick	Rapid colonization of fungal hyphae by antifungal bacteria in the rhizosphere
58	Suvi Ruuskanen	Long-lasting effects of yolk androgens on offspring phenotype
59	Bodo Schütze	Mauritius as a conservation flagship
60	Valentina Sechi	Biotic interactions and soil-based ecosystem services in complex landscapes
61	Tatiana Semenova	The effect of climate change on the composition of arctic soil fungal communities
62	Lisette de Senerpont Domis	Putting Aquatic Ecology into Practice
63	Sanne De Smet	Finding the Holy Grail in Production Ecology
64	Laura Soissons	How to better estimate collapse before it happens? Identifying seagrass resilience to disturbance under stress (nutrient)
65	Rutger Steever	Braving the salt marsh - plant traits over abiotic and biotic gradients
66	Lennart Suselbeek	Effects of scatter hoarding on cache pilferage by superior competitors
67	Sven Teurlincx	Working title: Regional scale biodiversity patterns in ditches in the Western Peat district of the Netherlands
68	Teresa Maria Vaello López	Environmental occurrence versus biodiversity within the anaerobic nitrite-driven methane oxidizing NC10 phylum bacteria

#	Name	Title
69	Mart Verwijmeren	Interspecific facilitation and critical transitions in arid ecosystems
70	Klaas Vrieling	A new SNP genotyping facility for evolutionary and ecological research
71	Andreas Waser	The impact of the shore crab (*C. maenas*) on littoral mussels (*M. edulis*)
72	Monique Weemstra	Beyond leaf economics: Integrating root, leaf and stem traits to examine resource acquisition and tree growth
73	Ellen Weerman	Predation of the native Brown shrimp on invasive Pacific oyster spat
74	Jennifer Welsh	Biodiversity Reduces Parasite Loads In Hosts
75	Hanneke Wiggers	The importance of ditch bank management for meadow bird chicks
76	Aron te Winkel	Plant-plant facilitation and local adaptation in a grazed salt marsh
77	Iris de Winter	The effect of habitat disturbance on the parasite prevalence in lemurs
78	Jelle Zandveld	The role of insulin-like peptides in nutrient-dependent lifespan and reproduction
79	Jianhua Zhang	Understanding Azole resistance in *Aspergillus fumigatus*: condition-dependent mutations for resistance and compensatory evolution
80	Junqi Zhu	Regulation of maize development in pure and mixed stands
81	Zhenchang Zhu	Who bury the seeds in salt marshes?
82	Feng Zhu	Hyperparasitoids Use Herbivore-induced plant volatiles to locate their parasitoid host