NAEM 2016

Netherlands Annual Ecology Meeting

9 & 10 February 2016

Congrescentrum De Werelt, Lunteren

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

Programme

Tuesday 9 February

	Main Entrance Hall			
08:30	Registration and coffee in the Lounge and setting up posters			
	Europe Hall			
10:15	**Word of Welcome** • Louise Vet (Chair of the Meeting, Netherlands Institute of Ecology) • Maurice Hoffmann (Chair NecoV, Research Institute for Nature and Forest)			
	Plenary 1: "Health and disease dynamics in wildlife: Ecological Immunology meets Ecology of Infectious Disease"			
10:30	1. **The Intimate Duality of Parasitism** (**Peter Hudson**, Penn State University)			
11.15	2. **Ecological Immunology: an energetic past, a microbial future?** (**Irene Tieleman**, University of Groningen)			
12:00	**Lunch in the restaurant**			
	Europe Hall	**America Hall**	**Asia Hall**	**Africa Hall**
13:30	**Parallel 1a:** **Disease interactions with communities and food webs**	**Parallel 1b:** **Carbon, Nitrogen and Water cycles**	**Parallel 1c:** **Linking Diversity to Function**	**Parallel 1d:** **Ecosystem-based solutions to societal problems**
	Conveners: 1. Kevin Matson (Wageningen University) 2. Thijs Frenken (Netherlands Institute of Ecology) 3. Anouk Goedknegt (Royal Netherlands Institute for Sea Research)	*Conveners*: 1. Paolo di Lonardo (Netherlands Institute of Ecology) 2. Maarten Braakhekke (Utrecht University) 3. Yasmina Loozen (Utrecht University)	*Conveners*: 1. Eiko Kuramae (Netherlands Institute of Ecology) 2. Emily van Loon-van Egmond (VU University Amsterdam) 3. Janna Barel (Wageningen University)	*Conveners*: 1. Simeon Moons (Royal Netherlands Institute for Sea Research) 2. Alexander van Oudenhoven (Leiden University) 3. Iris Pit (Utrecht University)
13:30	Tick burden of rodents as determinant of tick-borne disease risk (Tim Hofmeester, Wageningen University)	Carbon-nitrogen interactions across scales (Karin Rebel, Utrecht University)	Foundation species enhance food web complexity through random non-trophic facilitation (Annieke Borst, Radboud University Nijmegen)	The role of fundamental science and interdisciplinarity in the implementation of flood risk mitigation measures (Tjeerd Bouma, Royal Netherlands Institute for Sea Research)
13:50	Does heavy metal pollution affect immunological parameters of barnacle goslings after exposure to acute stress? (Margje de Jong, University of Groningen)	Climate change effects on nutritional quality of marine phytoplankton (Mandy Velthuis, Netherlands Institute of Ecology)	Functional diversity of soil protists (Stefan Geisen, Netherlands Institute of Ecology)	The role of vegetation in Building with Nature pilot sandy foreshore Houtribdijk (Marieke de Lange, ALTERRA)
14:10	Occurrence and determinants of variation in avian immune function in a tropical savannah (Chima Nwaogu, University of Groningen)	A model to assess benthic primary production in intertidal ecosystems at the macro scale (Tisja Daggers, Royal Netherlands Institute for Sea Research)	Linking microbial diversity with plant productivity, plant quality and disease control (Gera Hol, Netherlands Institute of Ecology)	Wetland eco-engineering: measuring and modelling feedbacks of oxidation processes between plants and clay-rich material (Rémon Saaltink, Utrecht University)
14:30	Short Break			

	Parallel Session 1 Continued			
14:40	Invasion-mediated changes in community structure affect parasite-host interactions (Anouk Goedknegt, Royal Netherlands Institute for Sea Research)	A trait-based approach to predict aerobic methane oxidation under environmental change (Annelies Veraart, Netherlands Institute of Ecology)	How selection towards a tragedy of the commons may modify diversity effects in plant communities (Peter Vermeulen, Wageningen University)	Modelling the spatial distribution of ecosystem service provisioning in agricultural landscapes (Marjolein Lof, Wageningen University)
15:00	Diversity determines the impacts of a microbial invasion (Cyrus Mallon, University of Groningen)	Organic matter amendment effects on soil microbial community, crop growth and nitrogen dynamics in a fertilizer experiment (Amber Heijboer, Wageningen University / Utrecht University)	The role of biodiversity and environment on productivity in tropical forests; evidence across scales (Masha van der Sande, Wageningen University / ALTERRA)	Environmental compensation for port extension: the case of Rotterdam harbour ('Maasvlakte 2') and development of new coastal dunes (Bert van der Valk, Deltares)
15:20	Temperature dependent transmission of West Nile and Usutu viruses by European mosquitoes (Giel Göertz, Wageningen University)	Home Sweet Home: specialist decomposers drive the breakdown of low-quality litter (Ciska Veen, Netherlands Institute of Ecology)	Biodiversity and ecosystem stability in the Anthropocene (Yann Hautier, Utrecht University)	Biodiversity and Ecosystem Services: does species diversity enhance effectiveness and reliability? (Carla Grashof-Bokdam, ALTERRA)
15:40	**Coffee and tea in the lounge**			
	Europe Hall	**America Hall**	**Asia Hall**	**Africa Hall**
16:00	**Parallel 2a: Cascading effects on vegetation: predators, herbivores, plants**	**Parallel 2b: Flooding: From plants to ecosystems**	**Parallel 2c: Overarching population ecology, genetics and life history**	**Parallel 2d: Long-term Ecological Research**
	Conveners: 1. Georgette Lagendijk (University of Groningen) 2. Chris Smit (University of Groningen) 3. Patrick Jansen (Wageningen University)	*Conveners*: 1. Valesca Harezlak (University of Twente / Deltares) 2. Judith Sarneel (Umeå University / Utrecht University)	*Conveners*: 1. Jelle Zandveld (Wageningen University) 2. Joost van den Heuvel (Newcastle University) 3. Daniel van Denderen (Danish Technical University)	*Conveners*: 1. Maurice Hoffmann (Research Institute for Nature and Forest) 2. Bruno Ens (Sovon Dutch Centre for Field Ornithology)
16:00	Anthropogenic effects on trophic cascades (Chris Smit, University of Groningen)	Compete or survive, a traits perspective (Judith Sarneel Umeå University / Utrecht University)	Linking genetics, evolution and ecology of sex allocation in the jewel wasp *Nasonia vitripennis* (Bart Pannebakker, Wageningen University)	The importance of Long-term Ecological Research (LTER) sites as research infrastructures (Maurice Hoffmann, Research Institute for Nature and Forest, Belgium)
16:20	Landscape of fear in Europe: wolves and humans shaping ungulate top-down effects (Dries Kuijper, Mammal Research Institute, Poland)	Adaptive adventitious root formation allows plants to cope with flooding (Qian Zhang, Radboud University Nijmegen)	Hybrid incompatibility in non-model systems: a plea for studying haploids (Bram Knegt, University of Amsterdam))	Long-term ecosystem and socio-ecological research in the Dutch Wadden Sea (Bruno Ens, Sovon Dutch Centre for Field Ornithology)
16:40	The effect of European bison behaviour on landscape heterogeneity (Janneke van Kessel, Utrecht University)	Spatial hydrological flow processes, water quality and vegetation community distributions in a natural floodplain fen (Floris Keizer, Utrecht University)	Past selection and local adaptation in European great tit genomes (Mirte Bosse, Netherlands Institute of Ecology)	Long-term forest ecosystem monitoring in Flanders, Belgium (Arne Verstraeten, Research Institute for Nature and Forest, Belgium)
17:00	Short Break			

	Parallel Session 2 Continued			
17:10	Climate change affects how we can control invasive species – with potential ecosystem-wide impacts (Ellen Cieraad, Leiden University)	Connecting willow species to ecosystem services for flood protection (Sophie Moinier, Deltares)	No degradation but regulation: transcriptomic changes as a mechanism for trait loss (Mark Lammers, VU Amsterdam)	Long-term monitoring reveals large impacts of an exceptional wet summer at a Siberian Arctic tundra site (Monique Heijmans, Wageningen University)
17:30	50 years later: large herbivore grazing as a tool to restore salt marsh vegetation in Het Zwin (Belgium, The Netherlands) (Jan Van Uytvanck, Research Institute for Nature and Forest, Belgium)	Positive interactions increase the persistence and recovery of salt marshes (Marlous Derksen-Hooijberg, Radboud University Nijmegen)	The best of both worlds: model organisms to study ecological traits (double slot) (Bregje Wertheim, University of Groningen)	Ground-truthing early-warning indicators of regime shifts using long term monitoring data (Alena Gsell, Netherlands Institute of Ecology)
17:50	The effect of lions on the spread of the grass *Cynodon dactylon*: a scale-dependent tri-trophic relation (Herbert Prins, Wageningen University)	Emergence of different river dynamics through changing vegetation patterns (Mijke van Oorschot, Deltares / Utrecht University)		Long-term study of great tit reproductive biology at the Hoge Veluwe National Park (Jip Ramakers, Netherlands Institute of Ecology)
18:10	**Drinks in the Lounge and from 18:30 onwards dinner in the restaurant**			
19:30	**Poster session 1: Odd-numbered posters (all linked to the sessions of the day) are presented and discussed**			
	Europe Hall			
21:00	**<u>Evening Programme:</u>** **Ecology is booming business, quite literally (Dr. Bart Knols)** With problems of speed, scale, and responsiveness interfering with mankind's ability to confront globalised problems with technological solutions, it is the field of ecology that benefits the most. More than ever before will ecological insight influences policy, politics and business. So, out of curiosity, what's your role as an ecologist in policy making, politics, or business? If you say 'none' than why are you an ecologist?			

Wednesday 10 February

07:30	Breakfast in the restaurant			
08:00	Registration for those coming on Day 2 only			
	Europe Hall	**America Hall**	**Asia Hall**	**Africa Hall**
08:30	**Parallel 3a: Spatial ecology: connectivity and functioning**	**Parallel 3b: Linkages between fire, vegetation, soil and ecosystem services; Separating facts from fiction?**	**Parallel 3c: Rhizosphere ecology: importance for plant health and biogeochemical cycling**	**Parallel 3d: Novel ecosystems: how to understand and manage them?**
	Conveners: 1. Tisja Daggers (Royal Netherlands Institute for Sea Research) 2. Myrna de Hoop (Utrecht University) 3. Annette Janssen (Netherlands Institute of Ecology / Wageningen University)	*Conveners*: 1. Cathelijne Stoof (Wageningen University) 2. Hans Cornelissen (VU Amsterdam) 3. Elmar Veenendaal (Wageningen University)	*Conveners*: 1. James Weedon (VU University Amsterdam) 2. Nadia Soudzilovskaia (Leiden University) 3. Stefan Geisen (Netherlands Institute of Ecology)	*Conveners*: 1. Jacintha Ellers (VU Amsterdam) 2. Wouter Halfwerk (VU Amsterdam) 3. Kamiel Spoelstra (Netherlands Institute of Ecology)
08:30	It's all around: Spatial ecology (Sven Teurlincx, Netherlands Institute of Ecology)	How fuel load and fire intensity (do not) control fire impact on ecosystems (Cathelijne Stoof, Wageningen University)	Rhizosphere ecology: a bird eye view from micro to global scale (Alexandre Jousset, Utrecht University)	Experimental illumination of a terrestrial ecosystem – gain and loss of habitat by artificial light at night (Kamiel Spoelstra, Netherlands Institute of Ecology)
08:50	Eco-evolutionary dynamics and the performance of metapopulation (Dries Bonte, Ghent University)	Fire effects on tropical woody vegetation structure have been exaggerated? (Elmar Veenendaal, Wageningen University)	Lost in diversity: the impact of plant diversity on the root mycobiome in natural grasslands (Liesje Mommer, Wageningen University)	Genotype-dependent gut microbiota drive zooplankton resistance to cyanobacterial harmful algal blooms (Emilie Macke, Leuven University, Belgium)
09:10	Rapid diversity loss of competing animal species in well-connected landscapes (Peter Schippers, ALTERRA)	The role of fuel type interactions in higher latitude fires (Luke Blauw, VU Amsterdam)	Soil community structure determines functional changes in nutrient dynamics facilitating vegetation succession (Elly Morriën, University of Amsterdam / Netherlands Institute of Ecology)	Strong top-down goat effects on the semiarid island of Bonaire (Nikkie van Grinsven, Wageningen University
09:30	Short Break			
09:40	Connecting local and continental scales: the European Network for the Radar surveillance of Animal Movement (ENRAM) (Adriaan Dokter, University of Amsterdam)	Fuel research in the Netherlands (Nienke Brouwer, Instituut Fysieke Veiligheid)	Additive effects of protozoa on plant growth and nutrient uptake (Sofija Andrić, University of Belgrade)	Effect of land use change on the exotic and native herpetofauna of the Dutch Caribbean (Wendy Jesse, VU Amsterdam)
10:00	Self-organization jointly regulates hydro-morphological processes and related ecosystem services: case study on aquatic macrophytes in streams (Loreta Cornacchia, Royal Netherlands Institute for Sea Research)	Disentangling the drivers of coarse woody debris behaviour and carbon gas emissions during fire (Weiwei Zhao, VU Amsterdam)	Soil thawing and fertilization effects on rooting pattern of grasses and shrubs in Siberian tundra vegetation (Peng Wang, Wageningen University)	Plant invasions: novel communities, same functions? (Bart Grutters, Netherlands Institute of Ecology)
10:20	Do spatially homogenizing and heterogenizing processes affect transitions between alternative stable states? (Thomas Groen, University of Twente)	Feedbacks between fire and patches of woody vegetation in tropical grasslands and savannas (Frank van Langevelde, Wageningen University)	Compositional and functional shifts in arctic fungal communities in response to long-term experimental snow depth increase (Tatiana Semenova, Naturalis Biodiversity Center)	Range expanding plant species relatedness with native flora determines the development of novel microbial and plant communities (Kadri Koorem, Netherlands Institute of Ecology)

10:40	**Coffee and tea in the lounge**			
	Europe Hall			
	Plenary 2: "Ecological Stoichiometry"			
11:00	1. **Ecological stoichiometry and resource ratio theory predictions for terrestrial plant systems** (**Stan Harpole**, Martin-Luther-Universität-Halle-Wittenberg)			
11.45	2. **N:P stoichiometry: Ecosystem functioning in a global change perspective** (**Martin Wassen**, Utrecht University)			
12:30	**Lunch in the restaurant**			
13:30	**Poster Session 2: Even-numbered posters (all linked to the sessions of the day) are presented and discussed**			
	Europe Hall	**America Hall**	**Asia Hall**	**Africa Hall**
15:00	**Parallel 4a:** **Elements matter: The stoichiometry of ecological interactions**	**Parallel 4b:** **Species on the move: range shifts, invasions and adaptation**	**Parallel 4c:** **Scaling from trait to environment and back**	**Parallel 4d:** **Population and community dynamics in systems under pressure**
	Conveners: 1. Dedmer van de Waal (Netherlands Institute of Ecology) 2. Martin Wassen (Utrecht University)	*Conveners*: 1. Monique de Jager (Utrecht University) 2. Nicky Lustenhouwer (ETH Zurich)	*Conveners*: 1. Franca Bongers (Utrecht University / Wageningen University) 2. Peter Vermeulen (Wageningen University)	*Conveners*: 1. Floor Soudijn (University of Amsterdam) 2. Karen van de Wolfshaar (IMARES)
15:00	Ecological stoichiometry of herbivore dung and implications for plants (Judith Sitters, Vrije Universiteit Brussel)	Species on the move: evolution in spreading populations (Nicky Lustenhouwer, ETH Zurich)	Scaling from trait to environment and back: examples from light competition (Franca Bongers, Wageningen University)	Population and community dynamics in systems under pressure (Floor Soudijn, University of Amsterdam)
15:20	N:P ratio explains plant species composition of grasslands independent from other environmental factors (Ineke Roeling, Utrecht University)	Timing of seed dispersal in wind-dispersed plant species (Jelle Treep, Utrecht University)	The impact of phenotypic plasticity in diet choices on the dynamics of complex life cycles (Louise Lassalle, University of Amsterdam)	Ecosystems off track: Rate-induced critical transitions in ecological models (Koen Siteur, Utrecht University)
15:40	Elements matter: from stable isotope ratios to indicators of conservation success (Marjolijn Christianen, University of Groningen)	Mastering migration: unravelling how internal and environmental factors shape individual migration routines and life-history traits (Wouter Vansteelant, University of Amsterdam)	Living Together or Apart: rooting responses to neighbours along a gradient of plant species richness (Natalie Oram, Wageningen University)	The complex food web effects of bottom trawling (Tobias van Kooten, IMARES)
16:00	Short Break			
16:10	Unbalanced reduction of nutrient loads has created an offshore gradient from phosphorus to nitrogen limitation in the North Sea (Amanda Burson, University of Amsterdam)	The role of migratory waterfowl in the global spread of highly pathogenic avian influenza (Erik Kleyheeg, Netherlands Institute of Ecology)	Predictability of species performance under climatic stress (Oscar Franken, VU Amsterdam)	Forest fragmentation and tree biodiversity – the effect on herbivorous arthropods (Irene van Schrojenstein Lantman, Ghent University)
16:30	Does aquatic plant stoichiometry reflect environmental nutrient availability? (Michiel Verhofstad, Netherlands Institute of Ecology)	Root-feeding nematodes prefer native plants, thereby indirectly favouring congeneric range-expanding plant species (Rutger Wilschut, Netherlands Institute of Ecology)	Legacy effects of arthropod community to next year's community composition and plant fitness, mediated by perennial plants (Jeltje Stam, Wageningen University)	Size-specific predation increases the body size and the commercial value of Nile tilapia populations in small lakes (Maria Cardoso, University of Amsterdam)
16:50	Changes in the functional response of the consumer *Brachionus calyciflorus* in response to resource stoichiometry (Kimberley Lemmen, Netherlands Institute of Ecology)	Expanding even faster: the evolution of mutation rate (Marleen Cobben, Netherlands Institute of Ecology)	Interactions between induced plant defences and insect herbivore community dynamics (Jorad de Vries, Wageningen University)	Coexistence of migratory strategies under ecological variation in *Salmo salar* (Catalina Chaparro Pedraza, University of Amsterdam)

	Europe Hall
17:20	• **Awards ceremony** o NERN Best Paper Award (Member of the NERN Evaluation Committee) o NecoV Poster Prize (Maurice Hoffmann) • **Final words** (Louise Vet)
	Lounge
18:00	**Farewell drinks**
18:30	**Dinner and NERN board meeting**
19:30	**End / Travel Home** (Shuttle available between Conference Centre and Lunteren Station between 19:00 and 20:00)

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Presentation Abstracts

Plenary Session 1

Health and disease dynamics in wildlife: Ecological Immunology meets Ecology of Infectious Disease

Our understanding of infectious diseases biology requires a multidisciplinary approach that stretches from immunology and molecular biology through to predicting pandemics. Not surprisingly issues are addressed from different viewpoints. On the one hand Ecological Immunology is rooted in life history evolution and ecophysiology, while on the other hand, The Ecology of Wildlife Disease is founded on synthesizing the biology of parasitology within a population dynamics framework. While an ecological approach has helped the larger field of infectious disease we shall now try taking this forward and explore how further integration could help our understanding of health and disease in wild animals.

1. **The Intimate Duality of Parasitism**
   (Peter Hudson, Penn State University)

Parasites live in a close and intimate relationship with their host such that any changes in one of the players can shape the dynamics of the other. In many instances such relationships are non-linear such that's mall changes can lead to large-scale impacts. We shall review the history of the ecology of infectious disease dynamics and look at some challenges for the future. Specifically we shall examine how parasites influence host fitness and the consequences on host dynamics and also how parasites can shape community structure. The challenges for the future lie both in understanding disease invasion, the community ecology of multiple infections and an interdisciplinary training on global health issues.

2. **Ecological Immunology: an energetic past, a microbial future?**
   (Irene Tieleman, University of Groningen)

Rooted in life history evolution, Ecological Immunology views immunity as costly trait involved in trade-offs of survival and reproduction. Over the past decades, tremendous variation in immunity has been described, among and within species and populations. Attempts to explain this variation in the context of life history evolution are frequently not successful. It is time for a paradigm shift, where immunity is placed more firmly in an environmental context. Characterizing the environment requires recognizing and quantifying elements that shape immunity: risk of infection, disease, or more general, "immunobiotic elements". This seems like a daunting task. Roughly, there are two approaches: 1. studying specific disease agents and the response of the host to these – the classical approach in Wildlife Disease Ecology, and 2. developing a less specific and more holistic qualification of the antigenic environment – a new perspective that connects with upcoming microbiome studies. In this presentation, I will give a brief historical overview of Ecological Immunology, evaluate its current challenges, and sketch potential future developments.

Plenary Session 2

Ecological stoichiometry

Ecological stoichiometry connects the relative availability of resources to the demands of organisms and the functioning of ecosystems. Worldwide changes in the C, N and P cycles affect the productivity, species interactions and structure of marine, aquatic and terrestrial ecosystems. Trophic interactions and species invasions interfere with stoichiometric (im-)balances and cascade through the ecosystem. In this session Martin Wassen and Stan Harpole will share their latest results from the grassland and wetland systems they study and how to deal with the global changes we are facing leading to uneven distribution of resources, scarcity, imbalances and species loss.

1. **Ecological stoichiometry and resource ratio theory predictions for terrestrial plant systems**
   (Stan Harpole, Martin-Luther-Universität-Halle-Wittenberg, Germany)

For autotrophic organisms the stoichiometry of elemental nutrient resources forms the basis for a mechanistic, resource ratio theory of species coexistence. Changes in the supply of multiple limiting resources can lead to loss of diversity and thus have important implications in today's world where human activities now dominate major nutrient cycles. Resource ratio theory makes several stoichiometric-based predictions for species coexistence, and models can accurately predict the dynamics of unicellular organisms competing for limiting resources in spatially and temporally homogeneous conditions. However, complex plant-soil systems violate most assumptions of simple resource ratio models and thus the theory may have limited application for terrestrial plant systems. Here I review the challenges for applying resource ratio theory to terrestrial plant systems and results from grassland studies testing theoretical predictions. Multiple nutrient limitation, resource stoichiometry-diversity relationships, plant impacts on resources, and plant community responses to changing resource supply, provide multiple lines of evidence and point to the utility of resource ratio theory for understanding plant biodiversity in a world undergoing changes in resource supply ratios.

2. **N:P stoichiometry: Ecosystem functioning in a global change perspective**
   (Martin Wassen, Utrecht University)

Most aquatic, marine and terrestrial ecosystems are co-limited by N and P, implying that the balance between these two potentially limiting resources matters for ecosystem productivity and functioning. Carbon and nitrogen availability are globally increasing by human-induced inputs, whereas the human domination of the P cycle is regionally distributed and less understood. Moreover, most of the earth P stocks are in rocks and deep oceans and available resources are shrinking rapidly. In terrestrial ecosystems we are currently facing regional plant species extinctions because of N- and/or P-enrichment. Recent results show that species traits and plasticity in traits are important for understanding how species interact in a changing N:P stoichiometric environment determining competitive outcome and vulnerability for extinction. Moreover, the expected balance between N and P might dramatically change in the near future. The consequences of stoichiometric dynamics for natural and managed ecosystems will be explored in the light of global change.

Parallel Session 1

1a: Disease interactions with communities and food webs

Conveners: Kevin Matson (Wageningen University)
Thijs Frenken (Netherlands Institute of Ecology)
Anouk Goedknegt (Royal Netherlands Institute for Sea Research)

1. Tick burden of rodents as determinant of tick-borne disease risk

Tim Hofmeester, Patrick Jansen, Sipke van Wieren
Wageningen University

The distribution of vectors over different hosts is a key determinant of the prevalence of vector-borne pathogens, but which factors influence the distribution of vectors over hosts is poorly understood. We compared *Ixodes ricinus* burdens of bank voles (*Myodes glareolus*) and wood mice (*Apodemus sylvaticus*) between 20 forest fragments across the Netherlands. As explanatory variables we measured species, sex and weight of the rodents; the abundance of deer as a proxy for tick density, and; the abundances of rodents and predators as determinants of rodent spatial behaviour. We found that tick burden was best explained by models including all factors, and that the abundances of rodents, predators and deer had the highest standardized regression coefficients. These results suggest that rodent density, behavioural responses of rodents to predation risk and the abundance of ticks in the environment were the main determinants of rodent tick burden. To test for the correlation between tick burden of rodents and the density of nymphs infected with rodent-transmitted tick-borne diseases, we drag-sampled questing nymphs in the same forest fragments, and used qPCR to test these nymphs for the presence of four tick-borne pathogens: *Borrelia afzelii*, *B. miyamotoi*, *Anaplasma phagocytophilum* and *Candidatus* Neoehrlichia mikurensis. The density of infected nymphs for all four pathogens increased significantly with tick burden of rodents. Our results imply that vertebrate community structure is correlated to the density of infected nymphs, via differences in tick burdens of rodents, which may in turn influence human disease risk.

2. Does heavy metal pollution affect immunological parameters of barnacle goslings after exposure to acute stress?

Margje de Jong, Isabella Scheiber, Nico van den Brink, Anna Braun, Maarten Loonen
University of Groningen

The toxic heavy metal mercury (Hg) is a common environmental contaminant, which can be traced back to both natural and anthropogenic sources. One of the anthropogenic sources of Hg contamination is mining, either from present day or historical activities. Studies on avian invertivores and piscivores have shown that mercury pollution can impair immune function. In the high Arctic, research has primarily focused on the effects of heavy metal contaminants on marine ecosystems, while possible effects on terrestrial ecosystems are less well understood. Our study focuses on an important terrestrial grazer in the Arctic, the barnacle goose (*Branta leucopsis*). We investigated immunological parameters (haemagglutination, haemolysis, nitric oxide concentrations, haptoglobin concentrations and differential blood count) at baseline and after exposure to an acute stressor, *i.e.* individual isolation, in barnacle goslings, which were exposed chronically to heavy metal pollution from an abandoned coal mine in Ny-Ålesund, Spitsbergen. We performed an experiment, in which one group of human-raised goslings grazed daily on the polluted mining area, while the other group went to forage on clean tundra (control area). Hg concentration in plant material in the mine was 2.2 times higher relative to the control area. Our results show that goslings that grazed in the mine area accumulated more mercury in their liver. There were no effects of Hg pollution on baseline immune measures. After exposure to the acute stressor, only the males seem to show a response to the treatment for the haemagglutination and haemolysis measures.

3. Occurrence and determinants of variation in avian immune function in a tropical savannah

Chima Nwaogu, Maaike Versteegh, Maurine Dietz, Irene Tieleman
University of Groningen

Variation in immune function is often linked to energetic trade-offs and variation in environmental conditions. Recent studies suggest strong environment effects, but environmental factors may co-vary with life history processes that elicit energetic trade-offs. Hence there is need to explore multiple type effects on variation in immune indices for particular environments. We determined which environmental factors were associated with variation in immune function in tropical savannah birds. Lysis and agglutination titres, and haptoglobin and ovotransferin concentrations were determined in plasma samples collected from 222 individual African Thrushes Turdus pelios and 209 Common Bulbuls Pycnonotus barbatus. Birds were caught between January–November 2014 within a 117 hectares reserve in Nigeria. We built general linear models with body size and mass, breeding and moult status, capture period , rainfall, temperature, humidity and wind speed as predictors. Trends in lysis and agglutination titres were similar for both species, but lysis and agglutination titres were higher in African Thrushes. 37% variation in lysis titre was explained by humidity, season, species, moult and

body mass. 9.4% variation in agglutination titre was explained by wind speed, season and species. Haptoglobin and ovotransferin concentrations did not differ between the species. Haptoglobin concentrations varied with season in Common Bulbuls, but for both species put together; variation was unexplained by any predictor variables. Finally, wind speed, season and tarsus length explained 21% of the variation in ovotransferin concentrations. In a tropical savannah, the variation in immune indices is explained by a combination of environmental factors varying per immune index and depending on species and individual differences.

4. Invasion-mediated changes in community structure affect parasite-host interactions

Anouk Goedknegt, Marieke Feis, Mathias Wegner, Pieternella Luttikhuizen, Christian Buschbaum, Kees Camphuysen, Jaap van der Meer, David Thieltges
Royal Netherlands Institute of Sea Research

The importance of local community structure in affecting parasite-host interactions has been increasingly recognized. Invasive species can alter community structure and thereby affect parasite-host dynamics that in turn can have knock-on effects on native communities and food webs. Here, I present several general mechanisms by which invasive species directly and indirectly affect parasite and host populations and communities. In addition, I will elucidate these mechanisms with empirical evidence from laboratory and field experiments on the effects of the invasion of the Pacific oyster (*Crassostrea gigas*) on parasite-host interactions in marine communities. The results will illustrate how invasive species can change community structure with subsequent effects on parasite and host populations and communities.

5. Diversity determines the impacts of a microbial invasion

Cyrus Mallon
University of Groningen

Using a biological invasion framework to examine the arrival of foreign microbes into a new community—akin to a pathogen entering a new host—offers the chance to use ecological and evolutionary principles to fight disease. *Escherichia coli* is primarily an organism of the vertebrate gut, but fecal shedding exposes this bacterium to the outside world with variable abiotic conditions and scarce resources. With its evolutionary lineage at stake in such external environments, like soil, *E. coli* must survive for an extended period of time for a chance to get acquired by a new host. This introduction of *E. coli* into the soil can be viewed within the context of a biological invasion, and examining the impacts of this invasion offers a window into the response of the resident microbial, particularly bacterial, community. In order to examine impacts, diversity gradients of soil microbial communities were created and subjected to invasion by a non-pathogenic derivative of *Escherichia coli* O157:H7. A quantification of the resident community composition, via next generation sequencing for the 16S rRNA bacterial gene, and niche differentiation, via resource use assays, revealed shifts to both parameters upon invasion. The data further suggests that a competitive release mechanism drives these impacts—*E. coli* likely competes with and reduces the abundance of the most dominant bacterial species, which alleviates competition and allows rarer species to grow. The extent of these impacts were amplified when diversity of the resident community was low, and this suggests that the maintenance of microbial diversity is crucial to stemming the spread and impact of pathogenic invaders, such as those of human and agricultural systems.

6. Temperature dependent transmission of West Nile and Usutu viruses by European mosquitoes

Jelke Fros, Corinne Geertsema, Chantal Vogels, Giel Göertz, Peter Roosjen, Anna-Bella Failloux, Just Vlak, Sander Koenraadt, Willem Takken, Gorben Pijlman
Wageningen University

West Nile virus (WNV) is a highly pathogenic flavivirus (family *Flaviviridae*). In southern Europe, a lineage 2 WNV strain has recently established itself, causing annual outbreaks in e.g. Greece and Italy. Additionally, the related flavivirus Usutu virus (USUV), has also recently emerged in Europe and caused outbreaks in various countries. Both WNV and USUV are transmitted between avian amplifying hosts by Culex species mosquitoes and infect humans and horses incidentally. We determined the vector competence of north-western European and American *Culex pipiens* mosquitoes for both WNV lineages and compared it to that of USUV. North-western European mosquitoes were highly competent for both WNV and USUV. Notably, transmission rates for lineage 2 WNV were significantly elevated in European mosquitoes, compared to those in American mosquitoes, due to better virus dissemination and a shorter extrinsic incubation time. We then explored whether temperature differences could influence vector competence. First, growth curves on mosquito cell lines demonstrated that WNV growth rates are significantly reduced at lower temperatures. Next, vector competence studies also showed that the infection rates of both WNV and USUV were enhanced at higher temperatures. Interestingly, at higher temperatures USUV infected significantly more mosquitoes compared to WNV. This study implies further epidemic spread during periods with favourable climatic conditions and suggests that USUV may precede WNV transmission in Europe. These results increase the need for intensified surveillance of virus activity and increased awareness throughout Europe.

1b: Carbon, Nitrogen and Water cycles

Conveners: Paolo di Lonardo (Netherlands Institute of Ecology)
Maarten Braakhekke (Utrecht University)
Yasmina Loozen (Utrecht University)

1. Carbon-nitrogen interactions across scales

Karin Rebel, Maarten Braakhekke, Katrin Fleischer, Yasmina Loozen, Martin Wassen, Stefan Dekker
Utrecht University

Carbon (C) and nitrogen (N) cycles are tightly linked since N is an important limiting resource for plant growth. Increased industrial activity, transport, and fertilization have and will increase N availability. However, the fate of N is not always clear, and neither how this affects C uptake in different ecosystem types and climate zones. Enhanced nitrogen availability can lead to increased growth, but above a certain level the system can become N-saturated, with decreased growth response and increased leaching of nitrogen to the groundwater. To study N induced growth versus N delivery to the groundwater, we ran the global vegetation model LPJ-GUESS. Next, we analyzed site observations of carbon and nitrogen indices from different global datasets to study how well the model predicts the N induced changes.

2. Climate change effects on nutritional quality of marine phytoplankton

Mandy Velthuis, Joost Keuskamp, Elisabeth Bakker, Ellen van Donk, Dedmer van de Waal
Netherlands Institute of Ecology

Climate change is a severe ongoing threat to aquatic ecosystems. Over the coming century, CO2 concentrations in the atmosphere are projected to at least double. As a consequence, temperatures will most probably rise by 3-5 degrees Celsius. Such changes in temperature and CO2 will affect marine phytoplankton in terms of production and nutritional quality. Being at the base of the aquatic food web, shifts in phytoplankton productivity may have far reaching consequences for the marine ecosystem as a whole. Here, we tested the effect of elevated CO2 and temperature on C:N:P stoichiometry of marine phytoplankton with a meta-analytic approach. We show that climate change leads to elevated C:N and C:P ratios in several phytoplankton groups. This may indicate decreased nutritional quality of phytoplankton in the near future and can therefore uncouple phytoplankton-grazer interactions.

3. A model to assess benthic primary production in intertidal ecosystems at the macro scale

Tisja Daggers, Jacco Kromkamp, Peter Herman, Daphne van der Wal
Royal Netherlands Institute for Sea Research

Quantifying spatial variability in intertidal benthic productivity is necessary to better understand the amount of benthic organic carbon available for grazing, burial and transport to the pelagic zone, and to improve global estimates of carbon sequestration in intertidal areas. However, there is no general method to routinely assess intertidal benthic primary production at the macro scale. Several 1D-models have been developed to calculate microphytobenthic primary production in intertidal areas, but none of these models are adapted to be used on larger scales, e.g. in combination with satellite remote sensing. In this study, we expanded the 1D-model from Forster et al. (2006) to a 2D-model and used remotely sensed information (Landsat 8) of microphytobenthic biomass and mud content as input. Photosynthetic parameters were measured on several locations in the Eastern and Western Scheldt and the photosynthetic capacity could be linked to ambient temperature. The method is validated on nine intertidal flats in the Eastern and Western Scheldt in the Netherlands. The model can be used in other estuaries to calculate total production and assess spatial variability in microphytobenthic primary production at the macro scale.

4. A trait-based approach to predict aerobic methane oxidation under environmental change

Annelies Veraart, Jiwei Cheng, Nick Bouskill, Eoin Brodie, Paul Bodelier
Netherlands Institute of Ecology

Wetlands are an important source of the greenhouse gas methane. The only known methane sink of biological nature is its oxidation by methanotrophic microorganisms. Although wetlands are under strong environmental pressure, impacts of environmental stressors - such as altered carbon and nitrogen availability - on methane oxidation remain unclear. Methanotrophs belonging to different phylogenetic groups have different ways of dealing with fluctuations in carbon and nitrogen. For instance, methanotroph guilds that have a more unspecific methane-oxidation enzyme are more affected by the presence of nitrogen fertilizer, which alters their methane oxidizing potential. To test how methanotroph community composition and functioning is affected by environmental change, we constructed a trait-based methane oxidation model. This model links methanotroph' carbon and nitrogen transforming pathways, using lab-obtained and genomic trait information. We used this model to predict community composition and methane-oxidation rates across pH, temperature, and nitrogen gradients. Community composition was strongly affected by temperature and nitrogen availability. In line with field observations, methanotrophs belonging to the gammaproteobacteria were sensitive to

ammonium, whereas alphaproteobacterial methanotrophs dominated under nitrogen-limited conditions. Including trait information in biogeochemistry models will lead to an improved understanding of human induced shifts in microbial community composition, and resulting feedbacks on greenhouse gas emission.

5. Organic matter amendment effects on soil microbial community, crop growth and nitrogen dynamics in a fertilizer experiment

Amber Heijboer, Hein ten Berge, Jaap Bloem, George Kowalchuk, Helene Bracht Jørgensen, Peter de Ruiter
Wageningen University / Utrecht University

The agricultural intensification of the last century has to a large extent been fuelled by the application of mineral fertilizer. Significant amounts of mineral fertilizer nitrogen (N) are being lost through leaching of mineral N to ground- and surface water, which has devastating implications for the environment. The low efficiency of N use in agricultural soils is to a large extent caused by the decoupling of carbon (C) and N cycles, since mineral N applications take over the role of the microbial community as a regulator of both decomposition and N mineralisation. The use of organic amendments can optimize agricultural N management by restoring this microbial link between soil C and N processing. We investigated how the chemical composition of different forms of organic amendments impacts the composition and activity of the soil microbial community, N dynamics and plant growth in a pot experiment. Application of high C:N organic matter had a stimulating effect on microbial biomass, activity and N recovery, and altered the soil microbial structure. Low C:N ratio organic amendments had almost no effect on microbial biomass and activity, however significant shifts occurred in the microbial community structure. The structure of the microbial communities could well explain the stimulating effects of low C:N ratio amendments on crop growth and N-fertilizer recovery in the plant. The increased insights in the effects of organic amendments on soil microbiology will help to enhance understanding of NUE in productive fields while preserving profitable agricultural crop growth.

6. Home Sweet Home: specialist decomposers drive the breakdown of low-quality litter

Ciska Veen, Ashley Keiser, Annemieke van der Wal, David Wardle, Wim van der Putten
Netherlands Institute of Ecology

Decomposition of plant litter is a key driver of nutrient and carbon cycling worldwide. Evidence is increasing that decomposer communities are specialized to break down litter from the plants they are associated with, referred to as “Home Field Advantage (HFA)”. However, the strength and direction of HFA effects varies greatly. Here we use a reciprocal litter transplant approach to elucidate under which conditions HFA occurs and how fungal communities respond to the input of new litter types. We found that HFA effects become stronger when litter quality declines, indicating that specialist decomposers are important for the breakdown of recalcitrant substrates. Fungal composition was driven by soil and litter type and shifts in fungal composition in response to new litter types depended on litter and soil origin. Our results imply that local plant-decomposer interactions may become disrupted when plants enter new communities, thereby altering the breakdown of plant litter and hence nutrient and carbon cycles.

1c: Linking Diversity to Function

Conveners: Eiko Kuramae (Netherlands Institute of Ecology)
Emily van Loon – van Egmond (VU Amsterdam)
Janna Barel (Wageningen University)

1. Foundation species enhance food web complexity through random non-trophic facilitation

Annieke Borst, Wilco Verberk, Christine Angelini, Els van der Zee, Marjolein Christianen, Tjisse van der Heide
Radboud University Nijmegen

Foundation species are described as spatially dominant autogenic ecosystem engineers that create habitat for other species. Habitat modification by foundation species has been found to enhance food web complexity by increasing the number of species and the number of links per species through non-trophic facilitation (i.e. positive interactions outside the food web) rather than their trophic effects (i.e. consumer-resource interactions). However, it remains unclear whether habitat modification results in the facilitation of specific species or links in the network, or if these mechanisms driving food web assembly are random. Here, we test the null-hypothesis that enhancement of food web complexity through non-trophic facilitation is random. In the field, we compared food webs in habitats with and without foundation species across 6 ecosystem types, including terrestrial, freshwater and marine ecosystems. Subsequently, we simulated the transition from foundation species-dominated to systems with unmodified, high-stress environments using an extended version of the well-established niche-model. Statistical comparisons revealed that many often-used food web metrics were affected by habitat modification and this was proportionate in the models and the real world. However, we also found that some food web metrics are highly variable across ecosystems and much more so than in the model results. We conclude that enhancement of food web complexity by foundation species can be well-approximated by assuming random non-trophic facilitation of species and links, but also argue that the resulting changes may nevertheless have important implications for overall food web stability.

2. Functional diversity of soil protists

Stefan Geisen, Wim van der Putten
Netherlands Institute of Ecology

Soil protists are the most diverse and abundant soil eukaryotes. Nevertheless, knowledge remains scarce especially on protist functioning as they are predominantly considered to represent the major controllers of bacteria in the soil food web. This potential bias likely emerged at least partially from the fact that many protists were isolated and kept using bacterial enrichment medium and from those, most ecological studies used just a single model protist. Using a combination of classical cultivation-based techniques, functional essays and state-of-the-are sequencing approaches we show that protists others than bacterivores, such as mycophages, nematophages, parasites and pathogens are diverse and common soil protists and most likely of substantial importance for functioning of soil food webs. Furthermore, the respective groups showed species-specific differences on their prey items, e.g. not all mycophages fed on all fungi equally. Therefore, soil protists cannot be grouped into the single functional group “bacterivores”; evidence for multiple functional roles of distinct protist taxa strongly suggests that the enormous protist diversity is meaningful for soil functioning. This, however, implies that a species specific resolution is essential to assign functions with consequences for community analyses: high taxonomic resolution needed for functional evaluations of protists and other soil organisms necessitates careful data interpretation, especially with the now commonly applied high-throughput sequencing approaches. Furthermore, functional studies need to supplement HTS data in order to fill the massive knowledge gaps on functioning of individual protist taxa to enable most meaningful data interpretation in future efforts.

3. Linking microbial diversity with plant productivity, plant quality and disease control

Gera Hol, Wietse de Boer, Wim van der Putten
Netherlands Institute of Ecology

Land use can have a strong impact on biodiversity and ecosystem functioning. The full extent of the impact of management on soil biodiversity is often unknown. Determining that species went locally extinct can be extremely difficult, and the potential consequences of microbial species loss for soil functioning might be underestimated due to expected functional redundancy. In our experiments we tested the effect of microbial species loss on abiotic parameters, on plant productivity and plant quality and on disease control. One important mechanism in the natural control of soil-borne pathogenic fungi is the production of antifungal volatiles by bacteria. The abiotic parameters were mostly robust to species loss, while the effects on plant productivity and quality heavily depended on the origin of the microbial community. In contrast, the production of antifungal volatiles by bacterial communities was generally reduced when species loss occurred. Hyphal growth of the pathogen *Fusarium oxysporum* correlated negatively with bacterial diversity. Our findings suggest that microbial species loss can have severe consequences for plant productivity and disease control.

4. How selection towards a tragedy of the commons may modify diversity effects in plant communities

Peter Vermeulen, Wopke van der Werf, Jasper van Ruijven, Niels Anten
Wageningen University

The analysis of how mixing of crops or varieties may affect yields increasingly follows the example set by ecologist on how to analyse biodiversity effects. The goal of mixtures is 1) to increase ecosystem services, or 2) to decrease the land needed to grow all crops that are present in mixtures. Here we show that for condition 1, natural selection may lead to lower yields (a tragedy of the commons), while it may lead to an increase in performance of the second system. We planted monocultures, mixtures, and invasion plots of three *Arabidopsis thaliana* types that only differed in the timing of bolting due to a change in one gene, and counted the number of pods at harvest. Monoculture yields were highest in the earliest flowering type, due to the trade-off between vegetative production and the time that is left for seed production after flowering. However, the later flowering types could invade and outcompete the earlier types. In mixtures, the later flowering types profited more from being in mixtures relative to their monocultures than the decrease in yield of earlier flowering ones; leading to a positive complementarity effect. We conclude that agronomists should take care that the way they analyse mixture yields relates to the goal of the mixture set up. Similarly, ecologists should make more clear whether the system is thought provide single or multiple ecosystem services; if not, shifts in frequency over time due to differences in relative fitness may be misinterpreted as being beneficial for ecosystem functioning.

5. The role of biodiversity and environment on productivity in tropical forests; evidence across scales

Masha van der Sande
Wageningen University / ALTERRA

Tropical forests store 25% of the terrestrial carbon and produce 34% of the gross primary productivity, which makes them crucially important in mitigating climate change. Furthermore, tropical forests are hyper-diverse, hosting around 47,000 tree species. The niche complementarity theory predicts that this high diversity increases the efficiency of resource acquisition and use and would therefore increase total productivity, whereas the mass-ratio theory predict that the traits of the most dominant species determine ecosystem processes. Both diversity and community-mean trait values (representing mass-ratio) have been shown to increase carbon uptake in relatively simple ecosystems, but it is yet poorly understood how this works for more diverse and structurally complex tropical forests. In this presentation, I will explain how biodiversity attributes (species diversity, community-mean traits and forest structure) and environmental conditions (soil, light and climate) determine productivity in tropical forests. I will do so by highlighting results obtained in different forests and at different spatial scales (local and continental).

6. Biodiversity and ecosystem stability in the Anthropocene

Yann Hautier
Utrecht University

With consensus emerging from experiments that generally support higher ecosystem stability in diverse assemblages, the key question has become whether such effect is real and important in natural ecosystems, especially those in which species diversity is threatened by anthropogenic global change. During this presentation, I will show (1) that plant diversity stabilizes the productivity of natural grasslands through asynchronous responses of species to environmental fluctuations, (2) that nutrient inputs threatens the stabilizing effect of diversity on ecosystem productivity, (3) that changes in plant diversity induced by global environmental changes are the key factor determining how global environmental changes affect ecosystem stability, and (4) that diverse communities are more stable because they exhibit resistance during extreme climate events. These findings indicate that there may be a universal impact of biodiversity on ecosystem stability with decreased plant species numbers leading to lower ecosystem stability. They also reveal underlying mechanisms on which scientists, land managers and politicians can act to stabilize ecosystem services in the face of global change.

1d: Ecosystem-based solutions to societal problems

Conveners: Simeon Moons (Royal Netherlands Institute for Sea Research)
Alexander van Oudenhoven (Leiden University)
Iris Pit (Utrecht University)

1. The role of fundamental science and interdisciplinarity in the implementation of flood risk mitigation measures

Tjeerd Bouma
Royal Netherlands Institute for Sea Research

Urban development and natural ecosystem functioning have often been opposites in the past. In recent years, our understanding of human dependence on ecosystem services has increased, suggesting the need for ecosystem-based solutions to societal problems. Coastal flood risk mitigation is one of the global challenges that can benefit greatly from the ecosystem-based approach. To create innovative ecosystem-based projects and to make them successful, the in-depth understanding of ecosystem functioning is of crucial importance. This fundamental knowledge can be gained from both large-scale, long-term monitoring and individual-based experimental studies. An interdisciplinary approach is necessary to successfully implement these scientific findings and secure sustainable land- and water use.

2. The role of vegetation in Building with Nature pilot sandy foreshore Houtribdijk

Marieke de Lange, Rik Huiskes, Arjen de Groot, Ellis Penning, Henk Steetzel, Jasper Fiselier, Sonja Ouwerkerk, Jaap van Thiel de Vries
ALTERRA

The natural situation of foreshores in shallow lakes with a gradual slope, sometimes a sandy beach and a well-developed riparian zone (submerged macrophytes and helophytes) is quite rare in the Netherlands. Still, the various ecosystem services that natural foreshores offer, e.g. attenuation of incoming wave action and habitat for fauna, gives inspiration to innovative solutions. Especially the wave attenuation service has received attention as a viable alternative to conventional dike reinforcement. To increase our understanding of a constructed foreshore, we applied 70.000 m^3 of sand along a 400 m long stretch of the Houtribdijk (Markermeer) during the summer of 2014, creating a foreshore with a gradual slope (1:30). The pilot was divided into four sections, two of which have an additional top layer of a sand-clay mixture to promote vegetation development. Each section was partially planted with selected wetland species, related to the possibilities and limitations to construct the desired abiotic environment. The vegetation is expected to deliver two ecosystem services related to flood protection: roots will prevent erosion of the sand, and aboveground biomass will dissipate wave energy. One of the chosen species is Common reed (*Phragmites australis*). To further enhance our understanding of the success of reed, we study the genetic diversity of Common reed in the Netherlands to identify if specific genotypes or phenotypes can be associated with its success at a given habitat. We present the first results of this genetic analysis and give advice on how this species can be promoted in newly constructed foreshores.

3. Wetland eco-engineering: measuring and modeling feedbacks of oxidation processes between plants and clay-rich material

Rémon Saaltink, Stefan Dekker, Jasper Griffioen, Martin Wassen
Utrecht University

Interest is growing in using soft sediment as a building material in eco-engineering projects. Wetland construction in Markermeer (a lake in the Netherlands) is an example: here the option of dredging some of the clay-rich lake-bed sediment and using it to construct wetland is being considered. Natural processes will be utilized during and after construction to accelerate ecosystem development. Knowing that plants can eco-engineer their environment via positive or negative biogeochemical plant–soil feedbacks, we conducted a six-month greenhouse experiment to identify the key biogeochemical processes in the mud when *Phragmites australis* is used as an eco-engineering species. We applied inverse biogeochemical modeling to link observed changes in pore water composition to biogeochemical processes. Two months after transplantation we observed reduced plant growth and shriveling and yellowing of foliage. The N:P ratios of plant tissue were low and were affected not by hampered uptake of N but by enhanced uptake of P. Subsequent analyses revealed high Fe concentrations in the leaves and roots. Sulfate concentrations rose drastically in our experiment due to pyrite oxidation; as these will decouple Fe-P in reducing conditions, we argue that plant-induced iron toxicity hampered plant growth, forming a negative feedback loop, while simultaneously there was a positive feedback loop, as iron toxicity promotes P mobilization as a result of root death, thereby enhancing plant growth and regeneration. Given these two feedback mechanisms, we propose that when building wetlands from these mud deposits Fe-tolerant species are used rather than species that thrive in N-limited conditions. The results presented in this study demonstrate the importance of studying the biogeochemical properties of the building material and the feedback mechanisms between plant and soil prior to finalizing the design of the eco-engineering project.

4. Modelling the spatial distribution of ecosystem service provisioning in agricultural landscapes

Marjolein Lof, Wopke van der Werf
Wageningen University

Agricultural landscapes consist of multiple habitats which influence populations of natural enemies and pollinators. Agricultural fields are often highly disturbed. The presence of semi-natural habitats in agricultural landscapes may support populations of natural enemies and pollinators throughout the year by provisioning alternative food sources or prey, and hibernation habitat, thereby serving as reservoirs and refuges for natural enemies and pollinators. In a seminal paper, Thies and Tscharntke (1999) used a correlative approach of spatially indexed regression to demonstrate that landscape structure had an effect on biological pest control. This widely used method can identify key habitats and assess the spatial extent of the ecosystem service. We extend this approach by positing that the amount of pest control at a given target site is the sum of contributions from different sources in the surrounding landscape. We assume that the spatial distribution of mobile ecosystem service providers around a point source can be described by a probability density function (kernel) depending on distance from the source. The model fitting result in biologically plausible parameter values for this distribution and weights for different habitat types in the landscape. Using a spatially explicit model for delivery of pest biocontrol services has the advantage that the ecosystem service can be calculated for each spatial location and that the effect of changes in the landscape can be studied.

5. Environmental compensation for port extension: the case of Rotterdam harbor ('Maasvlakte 2') and development of new coastal dunes

Bert van der Valk, Frank van der Meulen, Mennobart van Eerden
Deltares

In 2010, the harbor extension of the Port of Rotterdam ('Maasvlakte 2') was completed. The use of the new harbor area (increase of harbor traffic and atmospheric NOx deposition) was expected to damage the quality of valuable ecosystems in the existing dunes nearby, which are under protection of the EU Natura 2000 legislation. To compensate for this damage, a new dune area, Spanjaards Duin, was created north of Hoek van Holland. The new area is meant to provide space for development of moist dune valley (Natura 2000: H2190) and grey dune (H2130) vegetation. At the same time, a monitoring and evaluation programme was established. It will assess whether the predicted environmental damage indeed will occur in the nearby existing dunes, and whether the quality of the new nature area will compensate for this damage in the future. In this case, economic and natural developments go hand in hand, although from very different perspectives: harbor management vs. nature development and capital investment vs. a compensation for the loss of nature quality. The case of Spanjaards Duin demonstrates that care for environmental quality can go together with economic use of the coastal area. This is important for viable long term coastal management worldwide.

6. Biodiversity and Ecosystem Services: does species diversity enhance effectiveness and reliability?

Carla Grashof-Bokdam, Claire Vos, Paul Opdam
ALTERRA

We analysed scientific literature to clarify the importance of species diversity for effectiveness and reliability of seven ecosystem services. These ecosystem services are linked to several societal problems, such as climate change, water pollution, sustainable food production and threats to human health. We also assessed the role of the National Nature Network (NNN) and the network of small natural green elements (green infrastructure, GI) for ecosystem services. Results indicate that species diversity is important for ecosystem service effectiveness. Reliability however is not well studied. NNN and GI are important for ecosystem service effectiveness, but it is not yet possible to derive concrete guidelines on the required amount and spatial configuration of NNN and GI for optimal ecosystem service provision. We stress the importance of scientific knowledge for the implementation of ecosystem services in local landscape planning.

Parallel Session 2

2a: Cascading effects on vegetation: predators, herbivores, plants

Conveners: Georgette Lagendijk (University of Groningen)
Chris Smit (University of Groningen)
Patrick Jansen (Wageningen University)

1. Anthropogenic effects on trophic cascades

Chris Smit, Georgette Lagendijk, Patrick Janssen
University of Groningen

Trophic cascades occur when species change the abundance or behavior of taxa at lower trophic levels. Many studies have shown that these cascades are generally driven by predators that affect herbivores and thus vegetation and further levels. People affect these cascades through active reduction of predator and/or herbivore population levels, introductions, or by removal of species. In this session, we discuss such cascading effects with examples from different continents, such as rewilding with herbivores in the Oostvaardersplassen, herbivore management in fenced reserves in South Africa, and hunting impacts on seed predation in Panama. We will highlight current knowledge gaps and discuss potential future research direction of trophic cascades in (semi)natural ecosystems.

2. Landscape of fear in Europe: wolves and humans shaping ungulate top-down effects

Dries Kuijper, M. Churski, J. Bubnicki
Mammal Research Institute (Poland)

Large mammalian carnivores create areas perceived as having high and low risk by their ungulate prey. Despite the large body of literature from North American study systems, we know very little on how predator-prey interactions operate in more human-dominated landscapes. We studied how red deer perceive the landscape of fear in one of the least-disturbed areas in Europe, the Białowieża Primeval Forest, Poland. In several studies we addressed fine-scale and large-scale risk factors for red deer in this old-growth forest. By means of camera traps we showed that deer become more vigilant and reduce foraging in the vicinity of cues indicating predator presence (wolf scats). Deer also perceive tree logs, that block view and escape routes, as a fine-scale risk factor. The strength of these effects depends on the distance to the core of a wolf territory (large-scale risk factor); deer perceive tree logs as more risky and become more vigilant when wolves are more often present. At these locations deer browsing intensity on trees is reduced and more successful tree regeneration occurs with potential effects on tree species composition. Hence, in the Białowieża forest, wolves and tree logs create "patches of fear" with reduced deer browsing intensity. Humans are indirectly important, as wolf core areas are located far from human settlements. This 'human shadow' on predator-prey interactions is therefore an important component that should be taken into account in more human-dominated landscapes in Europe. Human presence, forestry and hunting potentially modify predator-prey interactions largely in other areas in Europe.

3. The effect of European bison behavior on landscape heterogeneity

Janneke van Kessel
Utrecht University

Increased landscape heterogeneity and biodiversity are benefits from animal-mediated disturbances including physical disturbance to soil/vegetation, nutrient redistribution, etc. Because of this, multiple herbivore species are now being introduced as landscape engineers, as for example the European bison in the Netherlands. Here we looked into whether bison wallowing – a very rapid physical disturbance on vegetation/soil – can be predicted from environmental and individual characteristics and behaviors. We used GPS telemetry data to determine bison behaviors (wallowing, resting, feeding, lengths and velocities of movements) and linked it to land cover type, sex, individual, life history traits, and season. We found that wallowing locations were clearly not at random, being clustered around the lake. The likelihood of wallowing increased when more time had passed since introduction, when bison had moved a larger distance from the previous wallowing spot, when bison were moving northwards or eastwards, and in the fall and outside the calving, rutting or breeding seasons. Our study indicates that bison can be important ecosystem engineers and be useful for increasing landscape heterogeneity. The absence of a very pronounced preference of European bison for certain land cover types implies that introducing bison is likely to enhance random dynamics in an area and is not suitable for restoration of target ecosystems.

4. Climate change affects how we can control invasive species – with potential ecosystem-wide impacts

Ellen Cieraad, David Latham, Cecilia Latham
Leiden University

Many studies assess the direct effects of either global change or invasion; however, of course they operate in tandem and this can create complex effects. Climate change may facilitate the abundance

and/or range expansion of invasive species, but it may also impact the ability to control and manage these invasions. Anthropogenic control of invasive mammals is generally most successful when the natural food supply is limiting; in temperate regions this is often in winter. We assessed the potential impact of climate change on rabbit control in southern New Zealand using temperature data. We show that a trend towards warmer winters in the last 60 years has significantly reduced the time window for effective management of rabbits. When human-induced global change results in warmer winter temperatures and increased vegetation growth, this may lead to ineffective management of the invasive herbivores, in turn resulting in increased grazing pressure on the vegetation, and potential effects on other trophic levels (particularly the abundance of invasive predators, like ferrets and cats). Climate change may thus exacerbate the unwanted impacts of herbivores by reducing our ability to manage them effectively. While similar effects have been previously reported for invertebrate pests, we believe this is the first example of such an effect for invasive mammals, and it is likely to be applicable to other species and systems – with obvious management and conservation implications.

5. 50 years later: large herbivore grazing as a tool to restore saltmarsh vegetation in Het Zwin (Belgium, The Netherlands)

Jan Van Uytvanck, Sam Provoost, Eric Cosyns, Arnout Zwaenepoel
Research Institute for Nature and Forest

After 50 years of abandonment, cattle grazing was reintroduced in the Zwin salt marsh (NW-Belgium). Forty Limousin cattle are present from July 1 till December 31 in a 75,6 ha grazing block. Across the Dutch border, sheep graze dyke and salt marsh vegetation. Grazing aims the restoration of typical pioneer salt marsh vegetation types by decreasing the cover of the locally dominant *Halimione portulacoides* and *Elymus athericus.* But are vegetation patches in which those species are dominant used by grazers? And are they able to reduce their cover in favour of other salt marsh species? We used vegetation mapping and telemetry to record positions of the herd every 15 minutes in 2014 and 2015. Further, we made paired vegetation relevés in two years grazed and ungrazed plots. Data showed a clear preference for grass dominated vegetation. Salt marsh vegetation was avoided, except the high and grass dominated (including *E. athericus*) salt marsh. Dune grasslands were highly preferred, which may partly be explained by the presence of the only drinking pond in this area**.** More than 95 % of all positions was found above the average high tide level, suggesting a strong avoidance of food plants that are daily flooded with salt water. Relevés showed that cattle grazing reduced the cover of *E. athericus* with almost 40 %. Effects of sheep grazing were less pronounced. Grazing management is a promising restoration measure for the Zwin salt marsh but needs some more years to allow the establishment of typical salt marsh species.

6. The effect of lions on the spread of the grass *Cynodon dactylon*: a scale-dependent tri-trophic relation

Herbert Prins
Wageningen University

Mathematically savannas can be described as if occurring at alternative stable states. In the field one can find areas where a savanna occurs as a short grass plain (a “lawn”), and elsewhere in the same region one can find areas with tall grass. Mathematically one can also describe a savanna in other alternative stable states, for instance in a grassy state or in a woody state. But do alternative stable states really exist? If so, then the trajectory from one state to another state is not easy to observe because points on this trajectory are according to the models not stable. We thus decided to execute experiments in Welgevonden Private Game Reserve (Limpopo Province, South Africa), and maintained these for the last 10 years. The experiments are scale dependent (smallest 10 m^2; largest 10.000 m^2) where we mow and fertilise; herbivores can freely move between plots and the surrounding matrix of non-treated savanna. We found a very strong effect of scale, which is mediated through lion predation: the sward-forming grass *Cynodon dactylon* starts spreading in the very large patches but not in the small ones. Top predators can thus influence vegetation composition at an unexpected level.

2b: Flooding: From plants to ecosystems

Conveners: Valesca Harezlak (University of Twente / Deltares)
Judith Sarneel (Umeå University / Utrecht University)

1. Compete or survive, a traits perspective

Judith Sarneel
Utrecht University / Umeå University

Flooding poses distinct stresses on plants, which they have to survive, and some species have traits that enable them to survive flooding. Plants that are not adapted to flooding can invest in traits that enhance competitive strength. We therefore wondered if the presence of others modifies the reaction to flooding and the recovery reaction after flooding. This was tested by a meta-analyse on 74 experiments describing the reaction of ca 180 plant species to flooding. This shows that, whenever plants are completely submerged, species with low Ellenberg values for moisture were more strongly affected by flooding compared to species with high Ellenberg values. Further, the negative effect of flooding was generally less in the presence of neighbours compared to the effect of flooding on individual plants. The effects of neighbors was therefore tested experimentally on 6 riparian species, that were grown alone and in presence of 5 conspecifics. This confirmed the pattern of the meta-analysis. Under flooded conditions, there was no size difference between plants grown alone and plants grown together, whereas there, obviously, was a big difference under moist conditions. This indicates that flooding stress could overrule competition effects on plant size. We further observed that plants grown together had somewhat higher root porosity compared to plants grown alone, showing that traits that enable survival to flooding can also be affected by competitive interactions. Therefore, survival to flooding is a complex interplay between species traits and competitive strength.

2. Adaptive adventitious root formation allows plants to cope with flooding

Qian Zhang, Eric Visser, Heidrun Huber, Hans de Kroon
Radboud University Nijmegen

Adventitious root formation is a common flooding response in wetland plants. We investigated if adventitious root formation is a trait specific for wetland plants, by zooming in on one species, Bittersweet (*Solanum dulcamara*), that inhabits both flooding- and drought-prone habitats. Responses to flooding and drought stress of 18 populations from contrasting habitats were compared in a common garden experiment. No difference in adventitious root formation and plant performance between populations originating from contrasting habitats was found. Instead, a high level of phenotypic plasticity was revealed in this species, suggesting low costs of maintaining such plasticity. The question arose to what extent these adventitious roots contributed to coping with flooding stress. We found large variation in the number of adventitious roots, which positively correlated with plant biomass within and among populations, suggesting an adaptive role of these adventitious roots in flooding tolerance. By manipulating the number of adventitious roots and recording nutrient uptake by these roots, we confirmed that adventitious roots facilitated plant growth by taking up nutrients during flooding. Moreover, as development of these roots takes some time, the positive effect on plant performance was only significant in long-term flooding events where adventitious roots reach sufficient numbers and length. Therefore, the natural variation of adventitious root formation may lead to differences in flooding tolerance of individual plants, particularly during long-term flooding, providing potential for selection on the plasticity of this trait.

3. Spatial hydrological flow processes, water quality and vegetation community distributions in a natural floodplain fen

Floris Keizer
Utrecht University

Flooding poses distinct stresses on plants, which they have to survive, and some species have traits that enable them to survive flooding. Plants that are not adapted to flooding can invest in traits that enhance competitive strength. We therefore wondered if the presence of others modifies the reaction to flooding and the recovery reaction after flooding. This was tested by a meta-analyse on 74 experiments describing the reaction of ca 180 plant species to flooding. This shows that, whenever plants are completely submerged, species with low Ellenberg values for moisture were more strongly affected by flooding compared to species with high Ellenberg values. Further, the negative effect of flooding was generally less in the presence of neighbours compared to the effect of flooding on individual plants. The effects of neighbors was therefore tested experimentally on 6 riparian species, that were grown alone and in presence of 5 conspecifics. This confirmed the pattern of the meta-analysis. Under flooded conditions, there was no size difference between plants grown alone and plants grown together, whereas there, obviously, was a big difference under moist conditions. This indicates that flooding stress could overrule competition effects on plant size. We further observed that plants grown together had somewhat higher root porosity compared to plants grown alone, showing that traits that enable survival to flooding can also be affected by competitive interactions. Therefore, survival to flooding is a complex interplay between species traits and competitive strength.

4. Connecting willow species to ecosystem services for flood protection

Sophie Moinier
Deltares

Willows are a naturally occurring species on river floodplains in the Netherlands (e.g. Index Natuur & Landschap) and are part of our cultural landscape. When willows are situated on the foreshores of river dikes, they could provide ecosystem services related to flood protection. Studies showed that willows are able to attenuate wave energy significantly. The benefits of this are (potentially) large: a reduced need for higher dikes and at the same time an opportunity to create other ecosystem services such as recreation. Aim of our study was to explore the link between willow species traits and ecosystem services. There are about 400 known willow species, and so far, roughly 5 of those species are actively applied for the purpose of flood protection. Our research focused on the following questions: Which plant traits are important for which ecosystem services on floodplains? What is the role of management? As a result, we have constructed a database in which we linked willow species to ecosystem services by defining plant traits that are important to deliver those ecosystem services. In the near future, we want to expand this database with other plant species.

5. Positive interactions increase the persistence and recovery of salt marshes

Marlous Derksen-Hooijberg, Christine Angelini, Leon Lamers, Annieke Borst, Fons Smolders, Jasper Hoogveld, Eva van den Elzen, Laura Govers, Sarah Faye Harpenslager, Hélène de Paoli, Brian Silliman, Tjisse van der Heide
Radboud University Nijmegen

Salt marshes are essential components of coastal zones worldwide and are structured by daily flooding – they are an important habitat for many species, function as carbon and nutrient sinks, and play a vital role in coastal protection. In recent decades, climatic changes such as sea level rise and increasingly severe and frequent droughts are causing large-scale ecosystem degradation of salt marshes. However, the underlying ecological mechanisms mediating salt marsh persistence and recovery potential are not well studied. Here we reveal in a full-factorial field experiment in the US how a mutualistic feedback between the marsh-forming foundation species *Spartina alterniflora* (cordgrass) and the dominant associated species *Geukensia demissa* (ribbed mussels) strongly enhances salt marsh persistence and recovery. We found that cordgrass facilitated mussels by enhancing mussel growth, presumably by providing attachment substrate and increasing food availability. In turn, by enhancing nutrient availability and reducing sulfide stress, mussels increased cordgrass biomass and enhanced cordgrass re-colonization of a former dieback site by 64%. Finally, a disturbance simulation (through clipping of all aboveground cordgrass biomass) demonstrated that - 13 months after clipping - cordgrass survival and regrowth were greatly stimulated by mussels, even though mussels were removed from the site during the clipping event. Overall we provide clear evidence that mutualistic interactions between cordgrass and ribbed mussels greatly enhance the persistence and recovery potential of salt marsh ecosystems. We therefore argue that inclusion of such positive interactions is vital for the success of salt marsh conservation and restoration programs.

Keywords: salt marsh, interactions, mutualism, persistence, recovery.

6. Emergence of different river dynamics through changing vegetation patterns

Mijke van Oorschot, Maarten Kleinhans, Gertjan Geerling
Utrecht University

Riparian vegetation interacts with morphodynamic processes in rivers to create distinct habitat mosaics supporting a large biodiversity. The aim of our work is to quantitatively investigate the emergent patterns in vegetation and river morphology at the river reach scale by dynamically modelling the processes and their interactions. Here, we coupled an advanced morphodynamic model to a novel dynamic riparian vegetation model and compared river morphology for scenarios with a range of vegetation strategies and eco-engineering properties. Scenarios include fast growing species with a short life span, slow growing species with a long life span, sensitive and resistant seedlings, species with high and low drag coefficients, species with different dispersal windows and species with different settling densities. In all scenarios vegetation colonizes bare substrate within the seed dispersal window, passes several growth stages with different properties and can die through flooding, desiccation, uprooting, scour or burial. We find that river dynamics, specifically sinuosity and sediment transport, are very sensitive to vegetation properties that determine vegetation density, settlement location and survival. In particular, a more dynamic vegetation cover causes lower sediment transport rates, bed level changes and higher sinuosity of the river. Future work will include the effects of invasive species, addition of silt and the effect of various river management strategies.

2c: Overarching population ecology genetics and life history

Conveners: Jelle Zandveld (Wageningen University)
Joost van den Heuvel (Newcastle University)
Daniel van Denderen (Danish Technical University)

1. Linking genetics, evolution and ecology of sex allocation in the jewel wasp *Nasonia vitripennis*

Bart Pannebakker
Wageningen University

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. Theoretical predictions of how organisms should allocate resources to male and female offspring in response to environmental conditions are now supported by a wealth of empirical data. This is particularly true for Hamilton's Local Mate Competition (LMC) theory. Briefly, LMC theory describes how females should allocate sex when related males (such as sons) compete for mates in locally structured populations. The most extensive exploration of LMC theory has occurred in parasitoids wasps however, especially in *Nasonia vitripennis*. Despite the success of sex allocation theory at the phenotypic level, we still know rather little about the underlying mechanisms of sex allocation at the molecular level. 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. In this presentation, I will my work on the genomics of facultative sex allocation in the parasitoid wasp *Nasonia vitripennis* in an evolutionary and ecological context.

2. Hybrid incompatibility in non-model systems: a plea for studying haploids

Bram Knegt, Tomos Potter, Martijn Egas
University of Amsterdam

Speciation genetics has hitherto focused on identifying genes that underlie differentiation between populations, i.e. "speciation genes". The next step would be to bring genetics into the field, and assess speciation genes and the adaptive value of their allelic variants in diverging populations. This approach, however, is complicated by the fact that most empirical work on hybrid incompatibilities has focused on diploid model systems, predominantly *Drosophila*, leaning heavily on lab-based tools and the availability of mutant populations. Lab tools are often not available in non-model systems, and mutant populations are not representative for natural interactions. In order to bridge this gap between the lab and the field, we have to identify systems in which hybrids are formed between natural populations, and in which the detection of proximate genetic causes of incompatibility does not depend on lab-based mutant populations. We argue that this is possible by identifying hybrid incompatibilities that are *incomplete*, and in sexual species with *haploid* life stages. As an example, we investigated genetic causes for incompatibility between differentiated lineages of a non-model species, the haplodiploid spider mite *Tetranychus evansi*. These lineages hybridize in nature, and by comparing genotypes of both viable and inviable hybrids we show that Bateson-Dobzhansky-Muller incompatibilities underlie their decreased fitness. We conclude that by choosing appropriate study systems, linking the genetic underpinnings of speciation with their ecological circumstances in the field comes within reach.

3. Past selection and local adaptation in European great tit genomes

Mirte Bosse, Lewis Spurgin, Jon Slate, Martien Groenen, Veronika Laine, Kees van Oers, Marcel Visser
Netherlands Institute of Ecology

The great tit (*Parus major*) is thought to consist of a large, panmictic population covering Europe and parts of Asia. Recent estimates of historical effective population size suggest that this population has been expanding for ~1 million years, with a mild effect of the last glacial maximum compared to terrestrial mega fauna. These findings suggest that the genomic variation landscape in great tits is likely to be highly homogeneous, despite the fact that this species occupies a wide range of environments. To what extent local adaptation in this species shapes variation at the genetic and phenotypic levels is, however, largely unknown. To answer these questions we screened the genome of ~2,500 great tits across 25 populations in Europe for ~500,000 markers on our recently developed high-density SNP-chip. We report the results of a detailed analysis of population structure and signatures of selection. We find that Southern European populations are genetically distinct from the rest of Europe, consistent with a scenario of southern refugia, but that Central and Northern populations are remarkably uniform in terms of genome-wide diversity. We find strong and consistent signatures of selection that are shared among European populations, suggesting past adaptation. We also find evidence for recent, local adaptation at the genomic level. Overall, we provide a comprehensive overview of the genomic variation landscape of great tits in Europe. Our findings significantly enhance our understanding of the ecological and evolutionary processes influencing

genomic and phenotypic variation in great tits, as well as the many other species that share similar life-histories.

4. No degradation but regulation: transcriptomic changes as a mechanism for trait loss

Mark Lammers, Peter Neleman, Ken Kraaijeveld, Jacintha Ellers
VU Amsterdam

Trait loss is shorthand for the evolutionary process where species have lost a phenotypic character, such as ecologically important traits which have profound consequences on the species' life-history. In many described cases trait loss appears to take place after the function of the trait is compensated for by an ecological partner or through the diet. The loss of a phenotypic trait is often accompanied by loss or pseudogenization of key genes, yet in some cases the genes underlying the trait remain intact despite the phenotypic loss, which suggest that regulatory changes play a role. Such is the case with the loss of *de novo* lipogenesis in parasitoids. Parasitoids are unable to produce lipids from dietary sugar, and rely on their host's lipid reserves for the bulk acquisition of energy. Our mechanistic understanding of the regulatory changes underlying cases like this one remains poor. In this talk I will present comparative transcriptomic data on sugar-fed and starved *Nasonia* parasitoid wasps and *Drosophila* fruit flies. My results show high similarity between species in gene expression levels overall, but contrasting patterns in specific processes related to glucose metabolism. I therefore propose that regulatory changes rather than gene decay cause trait loss in this system. By establishing gene regulation as an explanatory level for evolutionary changes in traits, my results enable us to expand trait loss theory with predictions on gene regulatory networks.

5. The best of both worlds: model organisms to study ecological traits (double slot)

Bregje Wertheim
University of Groningen

In this talk, I will provide an overview of the challenges and opportunities for studying the genetic architecture of ecologically relevant traits. New technologies vastly improved our ability to study genes and their interactions. Yet, the gene interaction networks that underlie life history traits are highly complex, they evolve and diversify rapidly. Genetic variation within molecular networks leads to the phenotypic variation that is subject to natural selection. To decipher the complexity of these networks and their evolution requires an interdisciplinary approach, combining ecological realism with genetic and genomic approaches. Elucidating how evolution modifies molecular networks can enable us to characterize the complex genetic architecture of adaptive traits. In my research, I aim to characterize the genomic variation for various ecological traits, and investigate how it affects the evolution of the intricate genetic networks underlying complex traits. I use *Drosophila* fruit flies and their ecological interactions as model system, because it allows us to combine understanding of their ecology with the formidable molecular toolbox and knowledge on mechanistic processes for various life history traits. I will describe our progress and the pitfalls of how we can exploit, quantify and characterize genomic variation to gain fundamental knowledge on ecological traits and evolutionary processes.

NB: This presenter has two time slots

2d: Long-term Ecological Research

Conveners: Maurice Hoffmann (Research Institute for Nature and Forest)
Bruno Ens (Sovon Dutch Centre for Field Ornithology)

1. The importance of Long-term Ecological Research (LTER) sites as research infrastructures

Maurice Hoffmann, Nathalie Cools, Bruno Ens
Research Institute for Nature and Forest

Long Term Ecosystem Research (LTER) sites are aimed at collecting relevant ecosystem (and/or socio-ecological) data and conducting (experimental) research that enhances our understanding of ecosystem functioning and ecosystem change, putting data as much as possible publicly available and additionally facilitate ecosystem, ecological and socio-ecological research of third parties. To illustrate the necessity of long-term data collection and research to solve pressing ecological and socio-ecological problems, we invited people to provide examples of such initiatives in this session. We start off with describing the state of the art of LTER-Europe, LTER-Belgium and LTER-Netherlands

2. Long-term ecosystem and socio-ecological research in the Dutch Wadden Sea

Bruno Ens
Sovon Dutch Centre for Field Ornithology

There are a large number of monitoring programs of abiotic, biotic and socioeconomic variables in the Dutch Wadden Sea area. For instance, water temperature has been measured in the Dutch Wadden Sea on a daily basis since 1861 and a systematic twice annual sampling program of benthic invertebrates was started in 1970. The WALTER project was funded in 2011 to improve integration, to identify gaps in the monitoring and to increase data availability. The resulting website www.walterwaddenmonitor.org features a.o. a data portal, an inventory of all monitoring programs and how these relate to an inventory of questions, assessments of current monitoring efforts with regard to major themes like tourism and climate change culminating in specific advice, and tools like intertides that calculate exposure time maps on the basis of bathymetric maps and water height measurements from the tidal gauges. Much effort was invested in linking ecological and socio-economic data. The proof of the pudding is in the eating, so we must learn in the coming year whether scientists, policy makers and managers consider the site a useful tool. It should help in proving or disproving claims that intense exploitation of the Wadden Sea has shifted the Wadden Sea from a state of low turbidity and high occurrence and density of seagrass and mussel beds to an alternative stable state characterized by a state of high turbidity and low occurrence and density of seagrass and mussel beds.

3. Long-term forest ecosystem monitoring in Flanders, Belgium

Arne Verstraeten, P. Roskams, J. Neirynck, Nathalie Cools
Research Institute for Nature and Forest

The forest ecosystem monitoring programme in Flanders encompasses 5 intensive monitoring sites of which one (Brasschaat) is highly instrumented for continuous meteorological and air quality measurements. The monitoring sites are part of UNECE ICP Forests. The main objective is to gain insight in the long-term response of forest ecosystems to chronic stress factors, in particular air pollution and climate change. At each plot the acidifying depositions are continuously monitored. Samples of precipitation, throughfall and stemflow (only for beech) are collected two times per month. In parallel samples of the soil solution are collected beneath the forest floor and at three depths in the mineral soil. Samples of each fraction are analyzed chemically (pH, conductivity, alkalinity and the concentrations of nitrogen, sulphur, metals and base cations). A tower, equipped with meteorological sensors and inlets for gaseous air pollution measurements (concentrations of NOx, O3, SO2) is installed in Brasschaat, which was also a research site in the NitroEurope and the CarboEurope integrated projects and is presently part of the ICOS (Integrated Carbon Observation System) research infrastructure programme. Results from the monitoring show that the total acidifying deposition (nitrogen and sulphur) decreased during the past two decades, in parallel with air concentrations of SO2 and NOx. This decrease is however countered by a simultaneous decrease in the deposition of base cations (K, Mg and Ca). The decreasing trend is reflected in the soil solution chemistry. Though, lichens and ground vegetation based critical loads for N are still being exceeded and critical limits for [base cations/Al] and anion neutralising capacity remain exceeded and soil acidification continues. The results show that this delay in recovery is due to soil buffering processes and decreasing depositions of basic cations.

4. Long-term monitoring reveals large impacts of an exceptional wet summer at a Siberian Arctic tundra site

Monique Heijmans, B. Li, P. Wang, J. Limpens, J. van Huissteden, T.C. Maximov, Frank Berendse
Wageningen University

In recent decades, shrub expansion has been observed in many places over the Arctic in response to climate warming. In 2007 we started research at a pristine Northeast-Siberian tundra site to

investigate the relationship between shrub cover and summer thawing of permafrost by experimentally removing the shrub part of the vegetation. This *Betula nana* removal experiment is still running. The removal plots changed dramatically after three to five years, illustrating the importance of running field experiments longer than the 3-year timescale of a PhD project. The treatment effects became stronger over time as a result of feedbacks between vegetation, permafrost thaw, water and snow, which turned the originally elevated shrub patches into waterlogged depressions and ponds (Nauta et al. 2015). Nine years of measurements in the unchanged control plots showed that the thawing depth was not largest in the warmest summer, as one may expect, but in the wettest summer, implying an important role for precipitation in this ecosystem. We think the exceptional wet summer of 2011 was a trigger for local permafrost collapse outside the experiment, which is confirmed by some preliminary results. The increased thawing induced melting of ice in the permafrost leading to soil subsidence and ponding of water. The resulting thaw ponds show drowning of the shrubs and high methane emission. If a future warmer and wetter climate can more frequently trigger such local permafrost collapse, methane-emitting wetlands would expand in the Siberian lowland tundra landscape, which contrasts with the widely assumed shrub expansion.

5. Ground-truthing early-warning indicators of regime shifts using long term monitoring data

Alena Gsell, Vasilis Dakos, Deniz Özkundakci, Ulrike Scharfenberger, Lars-Anders Hansson, Peeter Nõges, Philip Reid, Daniel Schindler, Ellen van Donk, Annika Walters, Rita Adrian
Netherlands Institute of Ecology

Ecosystems subject to gradually changing conditions can undergo sudden but persistent change in their internal organisation once a critical threshold is exceeded. These so-called regime shifts are difficult to predict as the system state may show little systematic change prior to the shift. Early-warning indicators (EWI) are statistical metrics of system resilience loss and have been shown to precede critical transitions in theoretical models, palaeo-climate time series, as well as in laboratory and whole lake experiments. However, the applicability of EWIs for detection of critical transitions in empirical time series of natural aquatic ecosystems remains untested. We assessed whether four EWIs (autocorrelation at lag-1, variance, skewness and density ratio) do precede regime shifts in six aquatic ecosystems that have experienced a regime shift and for which the relevant ecological mechanisms and drivers are known. Despite environmental noise and non-optimal sampling intervals EWIs preceded regime shifts regularly in 22 relevant state variables tested. Moreover, in some cases they were detectable several years ahead of the regime shift, potentially providing a window of opportunity for lake managers. However, the underlying processes driving ecosystem regime shifts need to be known a priori in order to choose relevant state variables and utilise EWIs to assess changes in the resilience of aquatic ecosystems.

6. Long-term study of great tit reproductive biology at the Hoge Veluwe National Park

Jip Ramakers, Phillip Gienapp, Marcel E. Visser
Netherlands Institute of Ecology

The year 2015 saw the 60th anniversary of a long-term study of hole-breeding passerines, including the great tit (*Parus major*), at the Hoge Veluwe National Park by the Netherlands Institute of Ecology (NIOO-KNAW). Since 1955, the great tit's reproductive biology has been studied systematically, which was later expanded to incorporate multiple trophic levels: the winter moth (*Operophtera brumata*), an important prey species of the great tit, and oak (*Quercus robur*), the main food source of the winter moth. To maximize their fitness, great tits must breed at the right time to be able to provide their nestlings with as much food as possible, so the phenology of these species needs to be well synchronized. In addition, data is collected on the annual beech crop, a main source of winter food for great tits. These time series have allowed for the study of fundamental questions in ecology and evolution using a food-chain approach. This has been especially of interest as the relationship between species within food chains are being disrupted by climate change. This may have consequences for patterns of selection and for the population dynamics of the species. In this talk we will give an overview of key questions addressed as a result of decades of systematic research, and explore avenues of future research.

Parallel Session 3

3a: Spatial ecology: connectivity and functioning

Conveners: Tisja Daggers (Royal Netherlands Institute for Sea Research)
Myrna de Hoop (Utrecht University)
Annette Janssen (Netherlands Institute of Ecology / Wageningen University)

1. It's all around: Spatial ecology

Sven Teurlincx
Netherlands Institute of Ecology

The spatial aspect of ecology has gained increasing attention in the past decades. Organisms utilize resources in space, affect the space around them, interact with other organisms and are themselves spatially organized. The spatial organization of organisms takes place on every scale, from patterning of micro-organisms in the soil to global distribution patterns of large animals. This spatial component of ecology may be seen as a nuisance to our experimental designs in the field, but it is also a source of information regarding responses of organisms, populations and communities. By studying the patterns and processes of spatial structure of organisms, we may gain a better understanding of the functioning of the ecosystem as a whole. A wide range of theories and concepts deal with ecology and its spatial component. In these theories developed concepts such as connectivity, habitat heterogeneity, transport and movement of organisms and transport of matter in space play a crucial role. This keynote talk will focus on illustrating theories and the underlying ecological processes relevant to the broad field of spatial ecology and will focus on the talks within the session specifically. Its central theme will be to explore the common grounds in questions and approach of these theories. This will help to set the stage for the rest of the session and provide food for thought for discussion during the session.

2. Eco-evolutionary dynamics and the performance of metapopulation

Dries Bonte
Ghent University

Organisms live usually –not to say always- in heterogeneous environments. Habitat patches vary typically in size and connectivity, and this variation determines population and metapopulation dynamics. While there is a large body of theory on how changes in metapopulation structure affect demography and evolutionary dynamics, empirical evidence remains extremely scarce. We installed replicated experimental metapopulation that vary in the spatial and spatiotemporal availability in habitat. The metapopulations were inhabited by spider mites living on bean leaf patches. Spider mites are arthropod herbivores with short generation times that are known to evolve fast in response to for instance host plant and pesticides. The used experimental metapopulations reflect the dominant metapopulation types in nature: a classical spatiotemporal variable metapopulation where patch extinction and colonization is common, a patchy metapopulation with patches of stable patches of similar size and mainland-island metapopulations that are characterized by stable patches that differ in size. We demonstrate that changes in metapopulation structure affect both the local and metapopulation-level demography. At the same time, these demographic changes impose evolutionary changes as reflected in life history, physiology and gene-expression. This phenomic approach indicated the evolution of a general stress response associated with spatial and spatiotemporal variation in habitat availability that in turn facilitated performance on a challenging host. To disentangle the contribution of ecology and evolution to the observed dynamics, we performed in silico experiments to test to which degree the evolved life history strategies affected individual- and metapopulation performance. We demonstrate that evolutionary changes predominantly affect population-level processes, while metapopulation dynamics appeared to be constrained by environmental constrains. Depending on the spatial configuration, evolution improved individual, population and metapopulation-level performance.

3. Rapid diversity loss of competing animal species in well-connected landscapes

Peter Schippers
ALTERRA

Population viability of a single species, when evaluated with metapopulation based landscape evaluation tools, always increases when the connectivity of the landscape increases. However, when interactions between species are taken into account, results can differ. We explore this issue using a stochastic spatially explicit meta-community model with 21 competing species in five different competitive settings: (1) weak, coexisting competition, (2) neutral competition, (3) strong, excluding competition, (4) hierarchical competition and (5) random species competition. The species compete in randomly generated landscapes with various fragmentation levels. With this model we study species loss over time. Simulation results show that overall diversity, the species richness in the entire landscape, decreases slowly in fragmented landscapes whereas in well-connected landscapes rapid species losses occur. These results are robust with respect to changing competitive settings, species parameters and spatial configurations. They indicate that optimal landscape configuration for species

conservation differs between metapopulation approaches, modelling species separately and meta-community approaches allowing species interactions. The mechanism behind this is that species in well-connected landscapes rapidly outcompete each other. Species that become abundant, by chance or by their completive strength, send out large amounts of dispersers that colonize and take over other patches that are occupied by species that are less abundant. This mechanism causes rapid species loss. In fragmented landscapes the colonization rate is lower, and it is difficult for a new species to establish in an already occupied patch. So, here dominant species cannot easily take overpatches occupied by other species and higher diversity is maintained for a longer time. These results suggest that fragmented landscapes have benefits for species conservation previously unrecognized by the landscape ecology and policy community. When species interactions are important, landscapes with a low fragmentation level can be better for species conservation than well-connected landscapes. Moreover, our results indicate that metapopulation based landscape evaluation tools may overestimate the value of connectivity and should be replaced by more realistic meta-community based tools.

4. Connecting local and continental scales: the European Network for the Radar surveillance of Animal Movement (ENRAM)

Adriaan Dokter
University of Amsterdam

Seasonal bird migration is an event of extraordinary magnitude, involving millions of individuals travelling large distances. These dynamic distributions of migratory birds across the European continent are an emergent pattern of both large and local scale processes. On a continental scale, synoptic weather systems and large-scale topography interact with the innate migration programmes of migrants. Locally, both biotic and abiotic habitat characteristics determine the suitability for refuelling and stopover. An exciting new development is the use of meteorological radars as sensors of bird movements and stopovers. These instruments have the unique potential to encompass the continental and local scales within migratory routes, and may thus be ideally suited to provide insight into the formation of continental distributional patterns of migrants. Weather radars can detect from which habitats birds initiate their migratory flights, quantifying over extensive regions which habitats are intensely used for stopover. These instruments are also organised in extensive networks (over 210 radars in Europe), such that migration patterns can also be quantified at continental scales. The European Network for the Radar surveillance of Animal Movement (ENRAM) is a new COST research network aiming to merge expertise in utilizing weather radars for the long-term monitoring and study of animal movement across Europe. After discussing the current knowledge gaps into our understanding of large scale migration patterns, I will discuss how recent achievements and current activities of ENRAM provide a step forward, using examples of local habitat association studies, and large-scale observations involving multiple radars.

5. Self-organization jointly regulates hydro-morphological processes and related ecosystem services: case study on aquatic macrophytes in streams

Loreta Cornacchia, Grieg Davies, Robert Grabowski, Daphne van der Wal, Johan van de Koppel, Geraldene Wharton, Tjeerd Bouma
Royal Netherlands Institute for Sea Research

Self-organized spatial patterns are predicted to have important emergent effects in terms of ecosystem productivity and resilience to disturbance. Whether and how self-organization may also promote ecosystem functions and services, leading to good ecological status, remains largely unknown. Here, we test the relationship between self-organization and ecosystem functions in streams colonized by aquatic plants, dominated by water crowfoot (*Ranunculus* spp.). First, we investigate the role of aquatic macrophytes as biological engineers of water flow patterns: using field measurements on two annual growth cycles, we show that seasonally-changing macrophyte cover maintains relative constant flow rates, both within and between the vegetation, despite changes in incoming discharge. By means of a mathematical model, we reveal that scale-dependent interactions between plant growth and flow redistribution explain the influence of macrophytes on stabilizing flow rates. Our analysis points towards important implications for ecosystem functions: the creation of fast-flowing channels allows an adequate conveyance of water throughout the year; yet, patches also act on sediment dynamics and overall lead to heterogeneous habitats, thereby facilitating other species. Thus, our last step is to investigate the effects of self-organization on the functioning of stream ecosystems, by exploring the relationship between changes in macrophyte cover and the provision of different ecosystem services (e.g. water conveyance, water quality, biodiversity). Our results highlight that, in biogeomorphic ecosystems, self-organization promotes the combination of multiple ecosystem functions through its effects on hydrological and morphological processes.

6. Do spatially homogenizing and heterogenizing processes affect transitions between alternative stable states?

Thomas Groen, Claudius van de Vijver, Frank van Langevelde
University of Twente

It is well established now that ecosystems can have alternative stable states, where under similar conditions, two possible states exist. Systems can switch between these two states as a result of external drivers. Such dynamics are well understood for spatially homogeneous systems and

increasingly so for spatially heterogeneous systems. When systems are spatially heterogeneous, sudden shifts between states can occur in local homogeneous patches but are averaged out over larger spatial area causing a more gradual response. Several spatial processes affect the spatial pattern of ecosystems. In savannas, a system also thought to have alternative stable states of trees and grasses, fires can maintain spatial patterns of woody vegetation, while dispersion by plants homogenize these spatial patterns. It is unclear how these two processes interact and affect possible transitions between alternative states in savannas. We modelled fire and plant dispersion in savannas and show how the interaction between the size of fire events and the rate of dispersion of plants creates spatial patterns in savannas under certain conditions. When dispersion is high, and the size of fire patches is small the spatial pattern becomes more homogeneous . We then show how systems with high and low heterogeneity, induced by these processes, respond differently to increases in grazing, an external driver. We find that when the spatial heterogeneity is low discontinuous responses occur, and that when spatial heterogeneity is high more gradual responses occur to this external driver.

3b: Linkages between fire, vegetation, soil and ecosystem services; Separating facts from fiction?

Conveners: Cathelijne Stoof (Wageningen University)
Hans Cornelissen (VU Amsterdam)
Elmar Veenendaal (Wageningen University)

1. How fuel load and fire intensity (do not) control fire impact on ecosystems

Cathelijne Stoof
Wageningen University

Vegetation plays a crucial role in controlling fire behavior but also in determining fire impact on ecosystems, through its mitigation potential for post-fire runoff and erosion. Another important factor in ecosystem changes is the biological, chemical and physical impact of fire on soils, which increases with increasing soil temperature. To predict fire impact on ecosystems, it is therefore essential to understand the drivers of soil heating during fire, and the relationship between fuel load, fire intensity and soil heating. Using data from the literature, from prescribed fires in Portugal and the Netherlands, and from a large-scale experimental fire in Portugal, I will show how shallow soil heating during moving fire fronts typically is. I will furthermore illustrate that at the landscape scale, soils can stay surprisingly cool where fuel load is high and fire is hot and, conversely, soils can get hot where expected to be cooler. The greatest fire damage to soil can therefore occur where fuel load and fire intensity are low rather than high. Without post-fire intervention, this means that spatial variation in fire damage and thus recovery potential can not only magnify already existing differences in degradation and ecosystem resilience across landscapes but also trigger nonlinear responses, complex feedback mechanisms, and tipping-point behavior.

2. Fire effects on tropical woody vegetation structure have been exaggerated?

Elmar Veenendaal, Mireia Torello-Raventos, Heloisa Miranda, Naomi Sato, Imma Oliveras, Frank van Langevelde, Izak Smit, Gregory Asner, Jon Lloyd
Wageningen University

Since the beginning of the 20th century scientists, particularly those working in Africa, have proposed a major impact of fire frequency and intensity on woody vegetation leading to concepts such as "fire derived" savannas and "fire-mediated" feedbacks. Particularly in contact zones between forests and savannas the role of fire has been proposed as the driving agent of replacement of fire-sensitive forest-associated species with fire sensitive "fire resistant" savanna species and transition from closed forest vegetation to open savanna vegetation. In this presentation we will provide a global synthesis of the fire experiment literature with an aim to determine if general patterns can be established in terms of magnitude of fire effects on tropical vegetation structure in terms of (a) season and frequency of burning; (b) vegetation structure in the absence of fire and (c) climate. With this body of empirical data and a simple simulation model we examine if, the impact of fire on tropical woody cover as currently presented in the literature and the role of fire-mediated feedbacks in forest-savanna transitions can be justified by empirical data emanating from long term fire experiments

3. The role of fuel type interactions in higher latitude fires

Luke Blauw
VU Amsterdam

Fire is an important natural process that affects environmental and global processes. In turn, global warming can affect fire regimes and increase carbon emission which could result in a positive feedback circle. Even though fires are a natural process, they have a great influence on human society. Recent fires in Indonesia are a well-known example that destructively affect the environment, human health and releases massive amounts of carbon. The carbon released was for a large part due to the peat combustion. In higher latitudes (peat)soils also contain tremendous amounts of carbon; the IPCC predicts roughly 1700 Pg. Therefore, higher latitude fires, although rare, can potentially emit tremendous amounts of carbon due to the great extent and high soil organic matter (SOM) availability. For this reason, it is necessary to determine under which circumstances these soil organic carbon can ignite and combust. Soil organic matter ignition is high energy requiring process which makes the initial phase dependent on external (aboveground) fire. In recent fire experiments in Scottish heathlands we examined the effect of fuel type composition on the above- and belowground fire behavior. We performed 14 prescribed fires, each 280 to 1200 m2, in both young and old heather stands. In each fire we manipulated the fuel composition at four positions and measured the above- and belowground fire behavior. Our (preliminary) results show that the interaction between vascular plants, mosses and litter affects the above- and belowground fire behavior.

4. Fuel research in the Netherlands

Nienke Brouwer, Ester Willemsen, Brian Oswald
Instituut Fysieke Veiligheid

The last few years numerous wildfires caused evacuations and threatened civilian life and property. In 2012 the national government set up a program to prepare emergency responders and civilians for these wildfires. In 2009 the Instituut Fysieke Veiligheid (Institute for Safety, the Netherlands) started on developing a spreadmodel for wildfires. Due to the smaller scale wildfires in The Netherlands, compared to the United States or Australia, a spreadmodel needs to be more precise and work on a much smaller scale. This spreadmodel has been operational and is supporting regional emergency agencies on the suppression of wildfires since 2013. Since then the focus has changed from wildfire suppression to risk management. The model makes a calculation of the spread of a wildfire in time, several factors are decisive for the speed and the spread of the fire. So are the drought of the vegetation, soil and the wind important factors. But also the biomass (and thus the burnable material), by mapping this factor the model can make a more accurate calculation of the spread of a wildfire in the Netherlands. Several fuel research are conducted in order to further develop this model. The research is conducted in cooperation with the Stephen F. Austin State University in Texas and University of applied sciences Larenstein. A modified field protocol from Ottmar and Vihnanek is used to estimate the surface fuels in dry heather areas, several dune vegetation types, understory forest and peatland. During the research in the dry heather area, research is also conducted in the understory of beech (Fagus sylvatica), douglas fir (*Pseudotsuga menziesii*) and Scots pine (*Pinus sylvestris*). For each vegetation type six different plots were conducted. Nine different fuel models were founded for these types, among them six custom fuel models. The following fuel research was conducted in the dune area. Thirty plots divided over dune grassland, open dune, dune heather, dune valley and dune shrub produced twenty fuel models. A year later research took place in peat bog, peat heather, peat shrub and peat forest. In total 23 plots divided over these four peat vegetation types were conducted. In total six fuel models can be linked with these vegetation types. During the fuel research, understory forest, 35 plots were performed divided over different forest types (peat-, dune-, mixed-, conifer-, and broadleaf forest) in different areas. The next fuel research will focus on crownfire and spotting.

5. Disentangling the drivers of coarse woody debris behavior and carbon gas emissions during fire

Weiwei Zhao, Guido van der Werf, Richard van Logtestijn, Jurgen van Hal, Johannes Cornelissen
VU Amsterdam

The turnover of coarse woody debris plays fundamental roles in global carbon cycling. Biological decomposition and fire are two main fates for dead wood turnover. Compared to slow decomposition, fire rapidly transfers organic carbon from the earth surface to the atmosphere. Both a-biotic environmental factors and biotic wood properties determine coarse wood combustion and thereby its carbon gas emissions during fire. Moisture is a key inhibitory environmental factor for fire. Dead wood properties strongly affect how it burns either directly or indirectly through interacting with moisture. Coarse wood properties vary between plant species and between various decay stages. Moreover, the soil and wood contact might also greatly affect their fire behavior. Using controlled laboratory burns, we disentangled the effects of all these driving factors: tree species, wood decay stages, moisture content, and soil-wood contact on dead wood flammability and gas efflux during fire. We found that wood decay stages have predominant effects on coarse wood combustion and associated carbon gas emissions during fire. Wood decay accelerates wood combustion and its CO2 and CO emissions during fire, which can be mainly attributed to the decreasing wood density as wood decaying.Our results provide quantitative experimental evidence for how several key abiotic and biotic factors, especially moisture content and the key underlying trait wood density, as well as their interactions, together drive coarse wood carbon turnover through fire. Our experimental data will help to improve the predictive power of global vegetation climate models on dead wood turnover and its feedback to climate.

6. Feedbacks between fire and patches of woody vegetation in tropical grasslands and savannas

Frank van Langevelde, Thomas Groen, Ignas Heitkönig, Navashni Govender, Ian Gaigher
Wageningen University

In tropical grasslands and savannas, fire is used to reduce woody vegetation expansion. Woody vegetation in these biomes is often patchily distributed with unknown consequences for fire effects. We studied two feedbacks between fire and patches of woody vegetation: effects of fire on tree clustering and effects of tree clusters on fire effects. The first feedback was tested by measuring the extent of tree clustering in Kruger National Park. We found that fire frequency positively affects the clustering of tree species that are not very abundant. We suggest that less abundant species are less resistant to fire and adopt a mechanism of clustering to exclude grass fires under their canopy. The second feedback was experimentally tested. We planted tree seedlings around wooded patches in a grassland and burnt these plots. We found that fire had lower temperature that prolonged for a shorter time period at the leeward side of wooded patches than at the windward side. Also, we found that the

seedlings were less damaged at the leeward side. We conclude that fire can result in clustering of trees and that these patches of woody vegetation can have a large effect on the role of fire in tropical grasslands and savannas. These two feedbacks may lead to a ‘safe zone’ for seedlings around patches of woody vegetation, which consequently promotes woody vegetation expansion. We modelled these findings and illustrate the results using changing frequency distributions of patch sizes. Our study contributes to understanding of savanna functioning by showing which processes are relevant in the distribution of savanna trees.

3c: Rhizosphere ecology: importance for plant health and biogeochemical cycling

Conveners: James Weedon (VU Amsterdam)
Nadia Soudzilovskaia (Leiden University)
Stefan Geisen (Netherlands Institute of Ecology)

1. Rhizosphere ecology: a bird's eye view from micro to global scale

Alexandre Jousset
Utrecht University

Plant roots form the interface between plant and a multitude of soil organisms. Bacteria, fungi and soil animals are together essential for securing nutrient supply and prevent diseases. Rhizosphere ecology is thus of crucial importance for plant growth. Further plant-soil interactions are a key driver of plant community composition and global nutrient patterns. The complex interactions between plant and soils can be seen from various angles and different research fields are linked together by plant-soil interactions. Different traditions have undergone divergent epistemological developments. The plurality of interpretations makes of this research topic rich and stimulating, yet to fully flower out it may require more interactions between traditionally disrupted disciplines. I will provide a bird-eye view on rhizosphere ecology, ranging from the microscale to global patterns. I will provide an overview on the historical developments of different disciplines linked to rhizosphere ecology, including microbiome research, soil food webs, soil ecosystem modelling. I will then compare how different traditions define desirable knowledge and develop tools and interpretation frameworks. Finally, I will provide perspectives on how combining these approaches can help solve current scientific challenges, from sustainable crop production to prediction and mitigation of greenhouse gas emissions.

2. Lost in diversity: the impact of plant diversity on the root mycobiome in natural grasslands

Liesje Mommer, Anne Cotton, Jos Raaijmakers, Aad Termorshuizen, Jasper van Ruijven, Marloes Hendriks, Judith van de Mortel, Jan Willem van der Paauw, Elio Schijlen, Annemiek Smit-Tiekstra, Frank Berendse, Hans de Kroon, Alex Dumbrell
Wageningen University

Plant diversity enhances ecosystem productivity, but the underlying mechanisms remain unclear. Recent studies suggest that reduced accumulation of plant species-specific fungal pathogens with increasing plant biodiversity is a key mechanism, but empirical support for host-specificity and pathogen dilution in the root microbiome in natural ecosystems is lacking. Here, we use a metagenetic (i.e. amplicon sequencing) approach to determine the composition of the root-associated fungal community (i.e. the root mycobiome) in a long-term grassland biodiversity experiment. We show that plant species have a distinct root mycobiome and that several of the identified fungi indeed have negative, species-specific effects on plant growth. We also show that the abundance of specialist pathogens declines with decreasing host abundance. Moreover, we found evidence for pathogen dilution as 50% of the fungal OTUs recorded in plant monocultures were not detected at high plant diversity. Our work suggests that root mycobiome composition changes with increasing plant diversity, which leads to reduced belowground pathogen pressure and a concomitant higher plant productivity in diverse plant communities.

3. Soil community structure determines functional changes in nutrient dynamics facilitating vegetation succession

Elly Morriën, S. Hannula, L. Snoek, J. van Veen, W. van der Putten
University of Amsterdam / Netherlands Institute of Ecology

The majority of current theory on plant community ecology has been based on vegetation succession at abandoned arable land. This shows how habitat filtering and competition for limiting resources structures plant community composition. Currently, there is consensus that plant community development is the result of those factors, as well as of interactions with their soil community. Here, we address the question how soil community structure affect nitrogen and carbon cycling during secondary succession. In 2011, we visited 9 grassland sites, categorized as recent, mid-term, long-term abandoned ex-arable fields. Bacteria and fungi were identified by pyrosequencing, while archaea were identified using TRFLP. The protists, micro-fauna, nematodes, enchytraeids and earthworms were extracted and morphologically identified until high taxonomic levels, often species level. In total, around 15 000 species were identified from the soils. We created a Spearman-rank correlation matrix based on abundance data of species which we visualized in a network as an overview of the soil community present. In 2012, intact soil cores with comparable plant vegetation were collected from the same sampling points. Stable isotope probing of the cores was performed using dual labelled ^{15}N ammonium nitrate ($^{15}NH_4{}^{15}NO_3$) and ^{13}C was fed to the plants in the form of $^{13}CO_2$. The soil food web structure was resolved by identifying the microbes using phospholipid markers and identifying soil fauna by morphology into similar groups as for the network analysis, both combined with isotopic measurements. We provide evidence that the conversion of soil food web structure appears to be more important than a quantitative change in biodiversity as such. Moreover, we show that structural

changes in the food web topology also leads to functional changes in the soil food web which can act as a driving force during land use change after human disturbance. Stable isotope analysis showed that plants in the long-term abandoned soil cores allocated less newly photosynthesized carbon to their roots and took up less nitrogen from the soil. Stable isotope analysis also showed that fungi and their consumers become more important in later successional stages, but that the fungal to bacterial ratio stayed constant over time. We can conclude that during secondary succession the system shifts in terms of function from bacterial dominated to fungal dominated. However, most changes in correlation strength of the network already occur in the early stages of secondary succession, suggesting that succession effects continue on a functional level after most interaction pathways become established in early successional stages.

4. Additive effects of protozoa on plant growth and nutrient uptake

Sofija Andrić, Paolo Carril Vaglini, Floor Haar, Alexandre Jousset
University of Belgrade

Protozoa are an often overlooked but crucial component of soil fertility. They influence the structure of bacterial communities and increase nutrient turnover, which can impact plant growth. The present study will test if protozoa increase plant growth and nutrient uptake by *Lolium perenne* growing in a natural clay soil. We added two protozoa, the amoeba *Rosculus terrestris*, the flagellate *Cercomonas lenta* and their mixture. We inoculated protozoa together with an organic fertilizer and followed plant growth, chlorophyll, nitrogen and micronutrients composition. We show that both protozoa increased shoot-to-root ratio, and the effect was twice as strong in plants inoculated with a mix of the two species protozoa in a clay soil. The greatest improvement in dry weight of shoots and roots was recorded in treatments with added *Cercomonas lenta*. Further, protozoa affected plant nutrition and enhanced the uptake of the macro-elements K and S as well as the micro-elements Cu and Zn. We conclude that protozoa can serve to enhance soil fertility and enhance plant growth when added in small quantity to a natural soil, offering new venues for bio-fertilizer applications.

5. Soil Thawing and Fertilization Effects on Rooting Pattern of Grasses and Shrubs in Siberian Tundra Vegetation

Peng Wang, Liesje Mommer, Juul Limpens, Frank Berendse, Trofim Maximov, Monique Heijmans
Wageningen University

Climate warming is predicted to be faster in Arctic areas than other regions in the world, which can increase soil thawing depth and nutrient availability in tundra ecosystems, thereby affecting root growth and competition. We conducted a field experiment at a Siberian tundra site, in which we manipulated soil thawing depth and nutrient availability, to investigate their effects on vegetation composition, and particularly, on the biomass and vertical distribution of the roots of grasses, sedges, deciduous shrubs and evergreen shrubs. We found that increases in thawing depth shifted root distribution of grasses to deeper soil layers, but had little effects on other plant functional types. Fertilization strongly increased root biomass of grasses and decreased that of evergreen shrubs and shifted root distribution of both grasses and evergreen shrubs to shallower soils. The shifts in rooting patterns indicated that the roots of the evergreen shrubs were out competed by the grass roots in the soil layer with the largest nutrient availability. Our results suggest that grasses are more plastic than the other plant functional types in tundra vegetation in terms of root vertical distribution, which may benefit them in the future warmer conditions.

6. Compositional and functional shifts in arctic fungal communities in response to long-term experimental snow depth increase

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

Climate warming leads to increased winter precipitation (snow depth) in the Arctic. This snow keeps arctic soils warmer during ca. 9 months of winter season, with subsequent effects on soil attributes and vegetation. Deeper snow has been shown to result in increased height and cover of shrubs and accumulation of leaf litter with corresponding decreases in shade-intolerant lichens and bryophytes. However, there is no published data on how experimentally increased snow depth affects tundra ecosystems below-ground, especially with regards to soil microbial communities. In the present work, we used DNA metabarcoding to study the effects of 18 years of experimental snow depth increase on soil fungi in dry heath and moist tussock tundra in Arctic Alaska. Although increased snow depth did not affect total fungal richness, we report significant changes of fungal community compositions in both the dry and the moist tundra. The observed shifts in taxonomic and functional groups suggest alterations in C budget of the ecosystems through decreased primary production with the loss of lichens, and enhanced decomposition rate caused by increased abundance of saprotrophs. This general trend, however, was accompanied by shifts in taxonomic and functional fungal guilds specific for each of the tundra types, as well by opposite responses observed for various taxa within one functional guild, suggesting that ecosystem type and fungal taxonomic identity should be taken into account when making projections regarding the future of arctic tundra with respect to climatic changes.

3d: Novel ecosystems: how to understand and manage them?

Conveners: Jacintha Ellers (VU Amsterdam)
Wouter Halfwerk (VU Amsterdam)
Kamiel Spoelstra (Netherlands Institute of Ecology)

1. Experimental illumination of a terrestrial ecosystem – gain and loss of habitat by artificial light at night

Kamiel Spoelstra
Netherlands Institute of Ecology

Artificial light at night has increased dramatically over the last few decades, and will continue to increase in the future. The disappearance of the natural night-time darkness affects numerous species across many ecosystems worldwide. Most effects documented so far comprise short-term effects such as attraction and deterrence of a limited number of species, and direct consequences on fitness and survival. There is however very little information on how most species in common terrestrial habitat is affected, and how this varies with the spectral composition of the light. A large-scale experimental study in the Netherlands is one of the first to provide information simultaneously collected on many species groups under white, red and green light in forest edge habitat. The impact on birds, bats, mice, insects and plants is monitored with the use of standardized protocols. Since artificial light is virtually always installed for long-term use, and latent, less direct effects are even less well understood, these protocols are repeated during many consecutive years. Here, we present the response to experimental lighting of several species groups, and identify the first long-term effects.

2. Genotype-dependent gut microbiota drive zooplankton resistance to cyanobacterial harmful algal blooms

Emilie Macke
University of Leuven

In recent decades, the synergistic effects of eutrophication and climate warming have led to a strong increase in the occurrence of cyanobacterial harmful algal blooms in lakes, ponds and reservoirs worldwide. Cyanobacteria are known to produce a range of powerful toxins, including microcystins, which cause various health problems and even death in livestock and humans. In aquatic ecosystems, cyanobacteria blooms have strong negative effects on zooplankton grazers and might threaten the stability of freshwater communities. Earlier studies have reported that toxin resistance in the main grazers of cyanobacteria is influenced by both genotype and earlier exposure to cyanobacteria. Through gut microbiota transplant experiments in the water flea *Daphnia*, we here show that genotype-dependent gut microbiota convey resistance to toxic cyanobacteria. Recipient *Daphnia* survived and reproduced better upon toxic cyanobacteria exposure when inoculated with the gut microbiota from resistant, but not from susceptible clones. The level of resistance to toxic cyanobacteria depended on the genotype of the donor but not of the recipient, suggesting that *Daphnia* genotypes does not influence resistance to cyanobacteria directly, but indirectly by shaping the gut microbial community. In addition, we found that the gut microbiota provided more effective protection when the donor had previously been fed toxic cyanobacteria, suggesting that the microbial community responded to become more efficient in degrading cyanobacterial toxins after prior exposure. Our results provide evidence that the gut microbiota acts as an extended phenotype of *Daphnia* genotypes that increases the capacity of the host to cope with foodborne toxins. As a result, gut microbiomes might be an important mediator of the genetic mosaic of coevolution between toxic cyanobacteria and their grazers, and a key determinant of how freshwater ecosystems respond to climate change.

3. Strong top-down goat effects on the semiarid island of Bonaire

Nikkie van Grinsven
Wageningen University

Goats were introduced to the Caribbean islands almost five centuries ago resulting in direct and indirect changes in terrestrial and surrounding marine ecosystems. We conducted both field and experimental studies to quantify the top-down effects of feral goats on the vegetation structure and composition of semiarid Bonaire. We found about 2.7 goats per hectare with a male:female sex ratio of 1:2. Goats have shaped the island vegetation dramatically. Comparing the vegetation of long-term (8 year) exclosures with paired adjacent plots reveals strong limitation of tree recruitment by goat browsing. No seedlings and saplings of late successional hardwood tree species grow outside the exclosures. Goats also browse on the three columnar cacti species limiting the establishment of new individuals and reducing adult fecundity thereby shifting population structure towards the dominance of adult individuals. Positive interactions between cacti and other plant species seem unable to significantly reduce the negative effects of current levels of herbivore pressure. These columnar cacti are keystone species that proovide essential food sources for native frugivorous and nectarivorous species during the dry season. On the other hand, goats seem to facilitate the dispersal of stem-succulent *Opuntia* cacti in the understory of current thorny shrublands. Our results suggest that the vegetation of Bonaire may be shifting from dry forests and columnar cacti towards an increasing

dominance of small cacti species. These strong top-down effects of a novel herbivore on the terrestrial plant communities may exacerbate soil nutrient runoff with deleterious impacts to the island marine ecosystems.

4. Effect of land use change on the exotic and native herpetofauna of the Dutch Caribbean

Wendy Jesse
VU Amsterdam

Anthropogenic factors are severely impacting the natural world through an array of mechanisms. Species communities inhabiting tropical oceanic islands are especially affected by the human-facilitated introduction and spread of exotic species as well as a relatively high level of land use change. These factors influence insular biodiversity in two ways: facilitation of exotic introductions will increase overall biodiversity, whereas intensifying human land use primarily endangers the native or endemic species with extinction, as they are often adapted to the more pristine environments on the islands. Furthermore, it is hypothesized that exotic and native species react differently to human impact, with exotics being better pre-adapted to the often anthropogenically disturbed habitat they initially invade. This would provide exotic species with a competitive edge over native species assemblages as more and more habitat gets altered by human activities. Human impact as defined here could therefore cause major shifts in community composition, associated species interactions, and overall biodiversity on oceanic islands now and in the future. Despite the severity of threat, there is so far no theoretical paradigm with which we can predict future species invasions, species loss and subsequent effects of these human-initiated community shifts. Therefore, I aim to build such a predictive framework for herpetological species in the (Dutch) Caribbean. In this presentation I present my preliminary results on the effect of human land use on exotic and native herpetological communities on St. Eustatius and St. Maarten.

5. Plant invasions: novel communities, same functions?

Bart Grutters
Netherlands Institute of Ecology

Globalisation and climate change strongly facilitate invasions by non-native plants. Non-native plants threaten native biodiversity and can heavily modify invaded habitats. However, prior to invasion, many of these habitats had already been strongly degraded, often having lost key native plant species along with the food webs that depended on these native plants. Native plants are cherished for the habitat and food they provide, yet we know little about whether non-native plants might provide similar benefits. As the recovery of natives is slow and troublesome, non-native plants in novel ecosystems might act as an alternative foundation for native macrofauna, fish and waterfowl. We tested whether native and non-native plants provide similar ecosystem functions using multiple experiments with freshwater plants and the organisms that depend on them. Besides plant origin, we also searched for major plant traits that could explain the functions provided by plants.

6. Range expanding plant species relatedness with native flora determines the development of novel microbial and plant communities

Kadri Koorem
Netherlands Institute of Ecology

Current climate warming has enabled range expansion of multiple species to higher altitudes and latitudes but we know little about ecological consequences of this process. Studies on intercontinental invasions have shown that species that are distantly related to native flora have higher impact on native plant communities, while the mechanisms are largely unknown. Here we used a combination of experiments to ask: i) is the addition of range expanding plant species, which are distantly related to native flora (hereafter: distant expanders) leading to the formation of more novel soil communities compared to the addition of range expanding plant species, which have congeneric plant species in native flora (hereafter: related expanders)? ii) do novel soil communities facilitate the formation of novel plant communities, dominated by range expanding plant species? We grew plant communities consisting of native plant species, distant or related expanders for 14 weeks with soil communities from across Europe. Thereafter we used molecular methods to characterize soil bacterial and fungal communities conditioned by these plant communities and grew a new generation of natives, related and distant expanders with each of these soil communities. Our results demonstrate that indeed, soil bacterial and fungal communities that were associated to distant expanders, were different from microbial communities associated with natives and related expanders. However, soil communities associated to novel range expanders were more beneficial for the growth of related range expanders and natives. These results highlight the importance of phylogenetic relatedness in the formation of novel soil and plant communities following climate warming-induced range shifts.

Parallel Session 4

4a: Elements matter: The stoichiometry of ecological interactions

Conveners: Dedmer van de Waal (Netherlands Institute of Ecology)
Martin Wassen (Utrecht University)

1. Ecological stoichiometry of herbivore dung and implications for plants

Judith Sitters, Elena Valdés-Correcher, Martin Wassen, Natacha Brion, Claire Mourgues, Harry Olde Venterink
Vrije Universiteit Brussel

Nutrient availability is a very important controlling factor for composition and diversity of plant communities, but knowledge about it is mainly based on measurements and manipulations of nutrients in mineral forms. Far less is known about the importance of nutrients in organic forms such as herbivore dung. Here we show that dung of a variety of African and European herbivore species varies widely in nitrogen (N) and phosphorus (P) concentrations, as well as in their ratio (N:P) and ratios with carbon (C:N, C:P). These ratios in turn strongly determined N and P release rates from decomposing dung, with lower relative losses of the least abundant nutrient. Surprisingly, soil macrofauna (i.e., termites and dungbeetles) increased the relative losses of the least abundant nutrient, thereby stabilizing the ratio of N to P loss. Furthermore, we demonstrated that dung of different herbivore species (i.e., dung type) significantly influenced the diversity and composition of an experimental plant community in mesocosms fertilised with dung of either European bison, cow, horse, fallow deer or rabbit. The impact of dung type on diversity and composition of the plant community was as least as strong as, or stronger than, the effect of manipulating the amounts of dung by a factor six. Moreover, the effect of dung type on the plant community diversity could be predicted by both the supply level and stoichiometry of N and P in it. The dung type with the most balanced N:P supply (of rabbit) resulted in the highest evenness of the plant community. These studies show that the balance of nutrients in natural organic fertilisers influences the relative availabilities of N and P in the soil and hence strongly impacts plant community composition and diversity.

2. N:P ratio explains plant species composition of grasslands independent from other environmental factors

Ineke Roeling, Jerry van Dijk, Maarten Eppinga, Wim Ozinga, Martin Wassen
Utrecht University

Availability of water and nutrients impose important environmental constraints on species composition in terrestrial ecosystems. Species composition may be further constrained by saline and/or acid conditions, which can act as potential stressors for which many plant species have limited tolerance. Heinz Ellenberg estimated indicator values for these factors for c. 2800 European vascular plant species. He assigned ordinal values to species for each factor, indicating a species' relative position along a tolerance/requirement gradient. These values were based on expert judgement but were later calibrated by other researchers using field measurements. The Ellenberg values are now accepted as a means to infer environmental conditions from plant species composition. The Ellenberg factor 'nutrients' is considered to be a general proxy for total nutrient availability. Total nutrient availability is often regarded as the most important determinant of species composition. However, many recent studies from a variety of ecosystems have shown that the relative amount of nutrients (stoichiometry) is also an important environmental factor. In this study we analysed to what extent the N:P(:K) ratio in aboveground biomass explains grassland species composition. We compared the explanatory strength of the N:P(:K) ratio with that of productivity and other environmental factors (the latter based on Ellenberg values). For this purpose we used a database containing more than 600 sites and c. 600 species. Our results indicate that N:P ratio was the second most important explanatory variable for species composition. This finding has important implications for current nature management strategies, which generally only aim to reduce nutrient availability per se. Future strategies could target specific nutrients to adjust soil nutrient ratios in a conservation area.

3. Elements matter: from stable isotope ratios to indicators of conservation success

Marjolijn Christianen, T. van der Heide, S. Holthuijsen, K. van der Reijden, A. Borst, J. Jouta , T. Compton, S. Schouten, J. Sinninghe Damste, T. Piersma, H. van der Veer, J. Middelburg, H. Olff
University of Groningen

Marine ecosystems dominated by foundation species are degrading rapidly worldwide, leading to a need for novel community-level indicators of conservation and restoration success. Current studies often use species richness and diversity of specific trophic groups as indicators, but these ignore important aspects of interactions across trophic levels. In an unprecedented monitoring effort of scientists and nature organisations we analysed nitrogen (δ15N) and carbon stable isotope ratios (δ13C) at an exceptional high spatial (n=9165) and taxonomical resolution (178 species) in the Dutch Wadden Sea. In this presentation we first reveal the consequences of intertidal foundations species - mussel beds - for the Wadden Sea food web structure. We then show the relative carbon resource use

by animals in the Dutch Wadden Sea. And we conclude with how basic food web topology parameters can be used as indicators of ecosystem complexity and recovery.

4. **Unbalanced reduction of nutrient loads has created an offshore gradient from phosphorus to nitrogen limitation in the North Sea**
Amanda Burson, Maayke Stomp, Larissa Akil, Corina Brussaard, Jef Huisman
University of Amsterdam

Measures to reduce eutrophication have often resulted in a more effective decline of phosphorus (P) than nitrogen (N) concentrations. The resultant changes in riverine nutrient loads can cause an increase in the N:P ratios of coastal waters. During four research cruises along a 450 km transect, we investigated how reductions in nutrient inputs during the past 25 years have affected nutrient limitation patterns in the North Sea. This revealed a strong offshore gradient of dissolved inorganic N:P ratios in spring, from 375:1 nearshore towards 1:1 in the central North Sea. This gradient was reflected in high nearshore N:P and C:P ratios of particulate organic matter (mainly phytoplankton), indicative of P deficiency of coastal phytoplankton, which may negatively affect higher trophic levels in the food web. Nutrient enrichment bioassays performed on-board showed P and Si limitation of phytoplankton growth nearshore, co-limitation of N and P in a transitional region, and N limitation in the outer-shore waters, confirming the existence of an offshore gradient from P to N limitation. Different species were limited by different nutrients, indicating that further reductions of P loads without concomitant reductions of N loads will suppress colonial Phaeocystis blooms, but will be less effective in diminishing harmful algal blooms by dino- and nanoflagellates. Hence, our results provide evidence that de-eutrophication efforts in northwestern Europe have led to a large imbalance in the N:P stoichiometry of coastal waters of the North Sea, with major consequences for the growth, species composition, and nutritional quality of marine phytoplankton communities.

5. **Does aquatic plant stoichiometry reflect environmental nutrient availability?**
Michiel Verhofstad, Sven Teurlincx, Elisabeth Bakker
Netherlands Institute of Ecology

The stoichiometry of aquatic plants can be very flexible and this flexibility has important implications for their role in nutrient cycling and aquatic food webs, as it affects decomposition and palatability to herbivores. However, most studies on primary producer stoichiometry have focussed on plankton. In controlled experiment the stoichiometry of aquatic plants can be altered by changing the (ratio of) available nutrients. In field sites however, it remains unclear for many aquatic plant species to what extent stoichiometry is determined by environmental nutrient availability. This, in part, may depend on the aquatic plant's growth form: rooted submerged aquatic plants are able to access the sediment nutrient pool, whereas non-rooted plants are not. We hypothesize that aquatic plant N & P content is positively related to the sediment nutrient availability in rooted plants and to the water column nutrients in non-rooted plants. We tested this hypothesis in a field study, where we collected roughly 100 shoots of *Ceratophyllum demersum* (non-rooted) and *Elodea nuttallii* (rooted) from ditches and determined sediment and water column nutrient availability at each location. We complemented this dataset with a furthermore 3 submerged aquatic plant species from additional sites (fewer samples). We found high intraspecific variability in aquatic plant C, N & P concentrations collected from the different locations and the environmental nutrient levels did partly correlated with plant nutrient levels in field sites. This variability in plant stoichiometry can, in turn, have consequences for the fitness of herbivores feeding on these plants.

6. **Changes in the functional response of the consumer *Brachionus calyciflorus* in response to resource stoichiometry**
Kimberley Lemmen, Björn Rall, Sebastian Diehl, Steven Declerck
Netherlands Institute of Ecology

Anthropogenic alteration of the availability and relative ratios of essential elements (e.g. carbon, nitrogen, phosphorus) is a major stressor in freshwater systems. In contrast to primary producers, consumers exhibit more constrained C:N:P ratios, and may therefore have mechanisms to mediate the uptake of limiting as well as excess nutrients in the face of nutritional imbalance. Compensatory feeding has been suggested as a mechanism to deal with resource limitation as it allows consumers to increase the number of food particles consumed, and therefore the amount of the limiting resource. However, such a response may also lead to an increased uptake of excess nutrients. Alternatively, consumers may decrease the number of particles consumed in order to increase assimilation efficiency of the limiting nutrient by increasing gut retention time. Previous studies with rotifers have suggested that only growth rate is impacted by changes in algal stoichiometry. However, we have found evidence for increased ingestion rate in response to phosphorus limitation, providing evidence for compensatory feeding in *Brachionus calyciflorus*. The observed differences in functional response as a result of nutrient limitation suggest that resource stoichiometry has an important role in consumer-resource interactions. However, an additional experiment showed lower ingestion rates of animals fed with P-replete algae compared to animals fed with algae with similar C:P ratio but with a history of growth under P-limitation. These results indicate that elemental content is not the only determinant and that other morphological or biochemical cues may also be responsible for quality-related changes in feeding behaviour.

4b: Species on the move: Range shifts, invasions, and adaptation

Conveners: Monique de Jager (Utrecht University)
Nicky Lustenhouwer (ETH Zürich)

1. Species on the move: evolution in spreading populations

Nicky Lustenhouwer
ETH Zürich

Species movements lie at the heart of two important current ecological issues: the spatial advance of biological invasions and range shifts of native species with climate change. Yet much is still unknown about the movement capacities of species, and what factors promote and constrain these movements. Since evidence is accumulating that evolution can occur on ecological time scales, rapid evolution may play an important role in spreading populations. Here I will discuss three main levels at which evolution may operate during spread, and present an overview of current studies on this topic as well as the work that will be presented in this session. Firstly, the spread process itself may select for an increased dispersal capacity of individuals, highlighting the need for a better understanding of the constraints on the movement capacity of species. Secondly, spreading populations must adapt to the new abiotic and biotic environment they encounter. Examples include differences in climate or adaptation to new hosts, pathogens or consumers. Finally, selection is not the only evolutionary process operating in spreading populations: gene flow, drift and mutation need to be considered in the context of spread as well.

2. Timing of seed dispersal in wind-dispersed plant species

Jelle Treep
Utrecht University

Plant species disperse as seeds to colonize new habitat in order to respond to changes, including global climate change. It is crucial to understand seed dispersal accurately in order to make predictive models of range shifts of plant species and take action where needed. In wind-dispersed species, the timing of seed dispersal has been identified as a major determinant of dispersal distances. Recent studies have shown that timing of seed dispersal in relation to meteorological conditions is not random, but it remains unclear which mechanisms drive the selection of seed release conditions. Questions include: Which timescales are important in the timing of seed dispersal? What are the consequences of non-random seed release? To answer these questions we combined modelling and observations. Model optimization of a dynamic dispersal model with hourly wind input data showed that plants can increase the tail of the dispersal kernel by developing a wind speed threshold below which no seed release occurs. At the same time risk costs increase (such as seed predation and rain damage), which limits the possibilities for dispersal distance gain. We observe a similar, but more gradual, wind speed threshold in seven wind-dispersed species in our experimental setup, suggesting that plant species indeed have developed non-random release mechanisms to maximize dispersal distance. Incorporating non-random release in dispersal models may improve predictions of invasion, migration and colonization processes.

3. Mastering migration: unraveling how internal and environmental factors shape individual migration routines and life-history traits

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

Since the ability of migrant birds to cope with environmental change is determined by phenotypic plasticity in movement strategies it is vital to understand how young birds learn to migrate. Technological challenges in tracking juvenile migrants have long prohibited research into the ontogeny of migration. However, using a uniquely large set of life-long tracking data for 35 Honey Buzzards Pernis apivorus it is now feasible to unravel how early-life experiences drive migratory development at the individual level. Adult Honey Buzzards are highly faithful to breeding sites and staging sites in Africa, migrating along strategic detours around ecological barriers and through large-scale wind regimes. In contrast, juveniles initially find their way to Africa by themselves. While immature buzzards may spend multiple years in the rainforest before returning to Europe for the first time it is unclear how they find their way back to breed and how migration mediates natal dispersal. In this talk I show that wind conditions during the first autumn migration determine the longitude at which juveniles settle in the tropics, which affects the route they learn during their first spring migration. They learn strategic detours as adults, after advancing migration timing. Nevertheless, all birds return to settle breeding sites near their natal area regardless of individual experience and interactions with birds from other populations during early-life. These findings suggest juvenile Honey Buzzards are unlikely to colonize distant vacant patches, in contrast to some other migrants which are seemingly more susceptible to peer pressure and recent habitat changes.

4. **The role of migratory waterfowl in the global spread of highly pathogenic avian influenza**
Erik Kleyheeg
Netherlands Institute of Ecology

Recent outbreaks of highly pathogenic avian influenza across the world have raised concern about the sustainability of poultry production and public health. Many new strains of avian influenza have been shown to originate in East Asia, where a combination of increasing food demand and outdated poultry farming practices provide ideal circumstances for virus transmission and evolution. For the rapid worldwide spread of avian influenza viruses, migratory waterfowl such as ducks and geese are considered a more likely vector than the trade of poultry or poultry products. However, at least two conditions should be met before we can point a finger at waterfowl: firstly, they should be shown physically able to migrate over large distances during avian influenza infection, and secondly, the outbreaks of avian influenza in poultry should match in time and space with waterfowl migration. Past studies have revealed that low pathogenic avian influenza may be carried asymptomatically by some duck species, suggesting coevolution between the virus and its host. In contrast, some highly pathogenic strains have caused mass mortality in wild waterfowl. Similarly, some studies have reported a mismatch between avian influenza outbreaks and waterfowl migration, while others did show a close relation. In this presentation, I will review the current evidence for the relation between waterfowl migration and the global spread of highly pathogenic avian influenza, and identify priorities for future research.

5. **Root-feeding nematodes prefer native plants, thereby indirectly favoring congeneric range-expanding plant species**
Rutger Wilschut, Julio Pereira da Silva, Paolina Garbeva, Wim van der Putten
Netherlands Institute of Ecology

Range-expanding plant species may establish novel interactions with local soil organisms in their new range. However, the native soil community might not be adapted to root compounds produced by these new species. Therefore, interactions between range-expanders and native soil organisms might have different outcomes compared to similar interactions of related native plants. In turn, these altered interactions might influence the performance of the range-expanders. Here, we tested the hypotheses that 1) native root-feeding nematodes are more strongly attracted by native plants than by congeneric range-expanders, 2) root-feeding nematodes multiply better on native plants than on congeneric range-expanders and 3) in the presence of root-feeding nematodes, range-expanding plant species will have a competitive advantage over related natives. To examine nematode preference, we performed choice experiments with 2 native root-feeding nematode species, using 3 pairs of range-expanding plants and congeneric natives. Subsequently, we examined reproduction of the nematodes on these 6 plant species, and the effects of nematode preference on competition between native and range-expanding plants. Our results show that in most cases, root-feeding nematodes prefer native plants over congeneric range-expanders and that nematode multiplication rates were indeed higher on their preferred hosts. Furthermore, range-expanding plant species that compete with native congeners can benefit from the disproportional performance of root-feeding nematodes on native plants. We conclude that in new ranges, range-expanding plant species can benefit from naïve natural enemies as these favor native plants over range-expanders. These results can help explain the abundance of some range-expanding plant species in their new range.

6. **Expanding even faster: the evolution of mutation rate**
Marleen Cobben
Netherlands Institute of Ecology

The evolution of dispersal during range expansion increases invasion speed, provided that a species can adapt sufficiently fast to novel local conditions. Iterated founder effects during range expansion, however, cause low levels of local genetic diversity at these range margins. Mutation rates can evolve, too, under conditions that favor an increased rate of local adaptation, but this has thus far only been associated with asexual populations. As selection acts on the mutation that occurs at a gene under selection and not on the rate with which such mutations occur, the evolution of mutation rates is the result of indirect selection. The establishment of a particular mutation rate is thus restricted to genetic hitchhiking, which is highly sensitive to recombination. However, we hypothesize that under conditions of genetic similarity, typical for expanding range margins, the evolution of mutation rates in sexual populations is possible. Here we use an individual-based model to show that natural selection leads to co-evolution of dispersal rates and mutation rates in sexual populations under range expansion due to spatial sorting. The evolution of mutation rate is adaptive and clearly advances range expansion both through its effect on the evolution of dispersal rate, and the evolution of local adaptation. By this we extend the existing theory on the evolution of mutation rates, with possibly far-reaching consequences concerning invasiveness and the rate at which species can adapt to novel environmental conditions.

4c: Scaling from trait to environment and back

Conveners: Franca Bongers (Utrecht University / Wageningen University)
Peter Vermeulen (Wageningen University)

1. Scaling from trait to environment and back: examples from light competition

Franca Bongers, Peter Vermeulen
Wageningen University/ Utrecht University

The environment influences the responses of organisms, while the way organisms respond changes the environment. Such feedback loops play a role over several levels of organisation: from trait-organism interactions to trophic interaction and trait-environment dynamics over generations. In this session, several examples will be shown of such interactions. We will use two examples of plant-plant competition to illustrate our idea about the dynamic feedback loop. 1) Plants show phenotypic plastic responses to local light cues, and in return these responses change the light conditions within a developing canopy. Thus, in a short time-scale the plant phenotype and the light environment form a feedback loop. This feedback loop between plant phenotype and the environment occurs within the generation and has consequences for the way plants compete for light. This feedback loop will also affect the way phenotypic plasticity can evolve over generations. 2) The switch to flowering, which is a plastic response to plant density, is influenced by competition. How this plastic response should evolve over generations can be modelled by analysing the way the trait value that is competitively superior changes with density. Ideally, our work would link the underlying physiological mechanisms that drives trait expression. On the other hand, this trait expression is linked with the interactions between species and over trophic levels. The other talks in this session will serve as inspiration of how the link between (eco)physiology, ecology and evolution can be achieved.

2. The impact of phenotypic plasticity in diet choices on the dynamics of complex life cycles

Louise Lassalle
University of Amsterdam

Phenotypic plasticity, the possibility of a single genotype to produce different phenotypes depending on environmental circumstances, is observed frequently in nature. Phenotypic plasticity can prevent a drastic decrease of fitness in an individual or a population due to environmental change. Yet, it has long been ignored in evolutionary theories because of the difficulties to develop a general concept about the interplay of evolution and plasticity. However, modern theoretical studies enable defining the evolutionary costs and limits of plasticity. At the same time, studies with physiologically structured population models show significant ecological differences compared to classical models. During my PhD, I aim to explore if the link between plasticity and the environment can act as a driving force of the evolution of complex life cycles. I will do this using a structured population model and adaptive dynamics theory. A salamander population will act as a biological model to explore if phenotypic plasticity can play a role in the evolution of multiple life-history strategies. Here I present my first eco-evolutionary model, where I investigate the consequences of phenotypic plasticity in the choices of diet on the dynamics of complex life cycles.

3. Living Together or Apart: rooting responses to neighbours along a gradient of plant species richness

Natalie Oram, Janneke Ravenek, Jan Willem van der Paauw, Hans de Kroon, Alexandra Weigelt, Jasper van Ruijven, Liesje Mommer
Wageningen University

Individual plants are known to respond to neighbouring plants. These responses can roughly be grouped in two: aggregation and avoidance. A long-standing hypothesis in plant competition theory is that belowground, plants avoid each other by altering their root distribution by rooting more deep or shallow. This differentiation is expected to promote coexistence and enhance plant productivity. However, empirical evidence is limited, mainly due to the fact that distinguishing species in root biomass samples is notoriously difficult. We examined root biomass and root depth distribution of 13 species across a species richness gradient in the Jena Trait Based Experiment in 2012 and 2014. Root standing biomass was sampled at five depths until 40 cm, and the relative abundance of each plant species in each depth was determined by RT-qPCR; root distribution was calculated from these data. At the community level, we found that root biomass increased over a plant species richness gradient. Root biomass increased in the second year, with a greater proportion of root biomass allocated to deeper layers. In contrast to root biomass, the rooting depth distribution did not change over a species richness gradient. At the species level, the root depth distribution in mixtures was significantly different compared to when grown in monoculture. Also, the change in root distribution between monocultures and mixed cultures differed between species. The change in root distribution in mixture from monoculture was slightly negatively related to the difference of that species was from its neighbours, and this relation was stronger in 2014. We also found no evidence that having a different root distribution did not benefit individual species in terms of overyielding. Based on these preliminary findings, we conclude that species change their root depth distribution over a species richness

gradient. However, we found no evidence that this response was directly related to the rooting pattern of their neighbours.

4. Predictability of species performance under climatic stress

Oscar Franken, Jacintha Ellers, Matty Berg
VU Amsterdam

How communities will respond to changing abiotic conditions is a major question in ecology. Simply analyzing the presence of component species is usually not enough to predict changes in community composition, because intraspecific variation of species traits can shape the many different species interactions. Instead, utilizing functional traits linked to the stressor of interest, and including both their intraspecific variation (population) and plasticity (individuals) can provide better insights in the expected community responses to abiotic stress. Here, we apply the functional trait approach to predict soil arthropod community responses to climate warming. We quantified the inter-and intraspecific variation of a trait which determines the physiological limit of survival at high temperatures, the Upper Thermal Limit (UTL), for the most important interacting taxa in our food web. The UTL showed significant interspecific variation, indicating that some taxa are more sensitive to extreme temperatures than others. These differences were used to predict the effect of three temperature regimes (constant temperature, mild, and extreme heat waves) on different food webs, which were tested in a mesocosm experiment. We found that UTL was a good indicator of species performance under extreme temperatures, where the most sensitive taxa showed increased mortality and reduced growth. On the contrary, taxa with the highest UTL benefitted from heat wave regimes, as growth rates increased. Moreover, we found that surviving individuals of the sensitive taxa showed reduced mortality during a subsequent exposure. Our findings indicate that using trait-based approaches can provide valuable insights in changing species interactions under stress.

5. Legacy effects of arthropod community to next year's community composition and plant fitness, mediated by perennial plants

Jeltje Stam, Martine Kos, Marcel Dicke, Erik Poelman
Wageningen University

Communities are highly dynamic, and arthropod communities associated with plants are no exception. Interactions between community members taking part in these dynamics can be indirect, mediated by other key community member(s), in this case the plant. Through herbivore-inducible plant traits, not only the current attacker, but also later community members are affected in a cascading way. As such, plants mediate herbivore-herbivore interactions and shape community composition. Plant-mediated interactions can have immediate consequences to community members, or have effects much later in time. Such legacy effects could be caused by temporal effects of an indirect interaction chain between community members, or *via* long-term induced trait changes in the mediating plant. Here, we looked at legacy effects of early herbivore-induced changes in the plant-associated insect community composition of one year, to the community composition in the following year. The natural associated insect community on wild perennial *Brassica oleracea* plants was monitored in a field setting during two consecutive years between spring and fall. At the end of the second season, seeds were harvested to assess the consequences of such legacy effects to plant fitness. Indirect legacy effects of community composition of the previous year to the next, and to plant fitness were indeed found, although early herbivory did not induce community composition changes. I will discuss the role of long-term induced plant traits in mediating legacy effects, and consequences for various ecosystem functions, as attacks to an herbaceous perennial plant might have longer lasting effects than initially thought.

6. Interactions between induced plant defences and insect herbivore community dynamics

Jorad de Vries, Jochem Evers, Erik Poelman
Wageningen University

Plants down-regulate their defences against insect herbivores upon impending competition for light, a mechanism that has been viewed as a static resource driven trade-off between investing in shade avoidance growth versus defence. However, plants integrate growth and defence in a highly dynamic environment where plants compete with neighbours and face a multitude of insect herbivore species. These species differentially favour defended or undefended plants, based on their susceptibility to the plants defences. Induction of plant defences upon herbivore infestation alters the attraction of subsequent herbivores, thereby changing the composition of the insect community. The composition of the insect community can in turn exert strong selection pressure on the adaptive value of plant defences. This feedback loop could have led to the down regulation of plant defences in a competitive environment. We make use of functional-structural plant modelling to simulate the spatial and temporal dynamics in the plant-plant-herbivore continuum. Using this approach we assess the impact of induced plant defences on plant fitness through physiological and ecological constraints. Such an exercise will lead us to critically re-evaluate whether, why and how plants integrate shade avoidance growth and defence.

4d: Population and community dynamics in systems under pressure

Conveners: Floor Soudijn (University of Amsterdam)
Karen van de Wolfshaar (IMARES)

1. Population and community dynamics in systems under pressure

Floor Soudijn, Karen van de Wolfshaar
University of Amsterdam

The human population on earth is expected to reach the record size of 8 billion people in the year 2040. As a consequence, natural ecosystems are increasingly under pressure from anthropogenic disturbances. Ecosystems are impacted, amongst other things, through habitat destruction and fragmentation and exploitation of natural resources. Over the last decades, it has become apparent that the effect of disturbances in natural systems may surpass the direct impact of a disturbance on a population, for example through trophic cascades. In addition, long term effects may surpass the short term effect. Yet, the eventual effects of disturbances are hard to predict as the complex and often indirect feedbacks between individuals, populations and their environment in natural systems hinders simple extrapolation. In this presentation, we aim to place the talks in this session in a general scientific framework. In addition, we will show an example of theoretical predictions regarding multi-species harvesting and in systems with multiple trophic levels. These predictions are based on models that consistently incorporate the feedback between different levels of organisation in natural systems (e.g. individuals, populations and trophic interactions). The results illustrate that predictions based on a mechanistic understanding of dynamics and interactions contradict the generally prevailing perception of direct and linear effects of disturbances on natural systems.

2. Ecosystems off track: Rate-induced critical transitions in ecological models

Koen Siteur, Maarten Eppinga, Arjen Doelman, Eric Siero, Max Rietkerk
Utrecht University

Theory suggests that gradual environmental change may erode the resilience of ecosystems and increase their susceptibility to critical transitions, which are associated to unexpected and hard to reverse ecosystem degradation. This notion has received a lot of attention in ecology over the past decades. An important question receiving far less attention is whether ecosystems can cope with the rapid anthropogenic environmental changes that are currently imposed on them. The importance of this question was recently highlighted by model studies showing that elevated rates of change may trigger critical transitions, whereas slow environmental change would not. Such rate sensitivity of models suggests that the common definition of ecosystem resilience may not be suitable for a subset of real ecosystems and that formulating limits to change may not always safeguard ecosystems against degradation. In this presentation I will i) give an overview of models that exhibit these so-called rate-induced critical transitions, ii) discuss complications regarding the analysis of rate sensitive models, iii) propose possible ways to identify rate sensitive ecosystems and iv) discuss the implications of my findings for management and future research.

3. The complex food web effects of bottom trawling

Tobias van Kooten, Karen van de Wolfshaar, Daniel van Denderen, Tim Schellekens
IMARES

In public opinion, bottom trawling embodies everything that is wrong with modern industrialized fisheries. It is associated with high discard rates and substantial seafloor disturbance, and has been compared to clearcutting a forest. These direct 'side effects' have been clearly confirmed experimentally. Bottom trawling is also one of the most common fishing methods worldwide, and because of this prevalence and the strong side effects, it has the potential to really change the ecosystems where it takes place. Yet, in empirical studies, we find that it is difficult to detect the effects of bottom trawling. We hypothesize that this is because of nonlinear feedback effects which are triggered in response to the combined direct effects of bottom trawling. We use a model of a simplified benthic food web to explore this hypothesis. We show that the combined effects of predation, competition, apparent competition and facilitation indeed lead to complex ecosystem responses to trawling, depending not only on the trawling intensity and ecosystem characteristics, but also on the exact specification of the gear used. This sensitivity to the parameter values of the model provides a potential explanation for the variability in outcomes found in empirical studies of bottom trawling.

4. Forest fragmentation and tree biodiversity – the effect on herbivorous arthropods

Irene van Schrojenstein Lantman, Dries Bonte
Ghent University

Human-induced changes in land-use causes habitat fragmentation and consequently biodiversity loss. Biodiversity at the level of primary produces increases the biodiversity bottom-up throughout the food web by supplying more niches. An increase in biodiversity in the entire food web allows for more interactions between species and thus increase the stability of the food web. Habitat fragmentation also affects biodiversity as populations extinctions increase when habitats get smaller. Also, the more an habitat is isolated, the less species will be able to colonize the habitat, selecting for the most mobile

species. In contrast to biodiversity increase in primary producers, habitat fragmentation is expected to affect the highest trophic levels the most, as predators need the largest area to sustain a population, but are generally also the most mobile. Placing functional biodiversity research in a fragmented landscape allows to study the combined effect of diversity loss and fragmentation on population dynamics and the stability of food webs. Focusing on one level above the primary producers, herbivores arthropods are practical model species for studying the combined effects of habitat fragmentation and tree diversity on community dynamics in a temperate forest. In 53 plots in Belgium the leaf miner community has been sampled. These plots all have the same history and are selected based on a fragmentation and tree diversity gradient. The overall abundance, species richness and diversity per tree is not affected by tree diversity. Unexpectedly, fragmentation has a positive effect. On a plot level the leaf miner communities are affected by fragmentation and diversity.

5. Size-specific predation increases the body size and the commercial value of Nile tilapia populations in small lakes

Maria Cardoso, André de Roos
University of Amsterdam

Tilapia's fast growth and high reproductive rates have made it one of the most important cultured freshwater fish in tropical lakes and reservoirs in Asia and South America. Generally it is thought, that a small lake size and stressful conditions are the cause for small tilapia body size and precocious maturity. Yet, experimental studies show that tilapia body size may be enhanced through piscivores that decrease competition among small-sized tilapias. We hypothesized that stunted growth in tilapia is caused by competition for food and investigated whether size-selective mortality by native predators in small lakes decreases Nile tilapia densities and leads to dominance of larger individuals. In this study we evaluate the size-structure of Nile tilapia in relation to the presence and absence of native piscivorous fish in 7 small man-made lakes during 2002 and 2008. We compared differences in population size-structure and density of tilapia. Our results show that in lakes with piscivorous fish, tilapia were less abundant but had higher mean and maximum size than in lakes without predators. As a consequence, total tilapia population biomass did not differ between lakes. Additionally, a higher total fish biomass (native fish and tilapia combined) occured in the presence of piscivores. The presence of native piscivorous fish results in tilapia populations with a higher commercial value while also positively affecting native fish populations. These results have important implications for fisheries management aimed to increase the commercial value of Nile tilapia fisheries and show the importance of size-dependent ecological interactions for fisheries management.

6. Coexistence of migratory strategies under ecological variation in *Salmo salar*

Catalina Chaparro Pedraza, André de Roos
University of Amsterdam

In several animal taxa such as birds (Lundberg, 1988), fishes (Chapman, Hulthen, brodersen, Nilsson, hansson, & Bronmark, 2012), amphibians (Grayson, Bailey, & Wilbur, 2011) and insects (Rankin & Burchsted, 1992) populations include individuals that migrate between two different habitats, while other individuals remain resident in only one of the habitats. For example, populations of Atlantic salmon (Salmo salar) often contain a mixture of anadromous and non-anadromous individuals, but those populations are under enormous anthropogenic pressures due to exploitation and dam construction. How these alternative strategies coexist in the same population is, however, not clear and it is crucial to generate effective conservation policy. Despite migration has enormous consequences for life history as it implies a niche shift, to our knowledge, theoretical studies have not addressed the question above taking into account the structure of the population and the density-dependent feedback on the conditions for individual growth and reproduction. To approach the problem of coexistence of alternative strategies in migratory species, we implemented a structured population model based on a Dynamic Energy Budget (DEB) model describing the life history at the individual level and parameterized with data of Atlantic salmon (*Salmo salar*). Using this model we will show how changes in environmental factors, such as food availability, energetic cost and mortality affect the coexistence of alternative migratory strategies and shape the potential life history trajectories.

Poster titles and numbers

Please note that during the poster session on Tuesday all **odd-numbered** posters will be attended /discussed and on the poster session of Wednesday all **even-numbered** posters will be attended /discussed. Also note that in the last column, you can see to which of the parallel sessions the poster is linked (if applicable).

#	Name	Poster title	Relevant session
1	Mario Diaz	Assembly history determines the functioning of probiotic bacterial communities	Parallel 1a
2	Javier Alegria	Microphytobenthos interaction with two important mudflat bioengineers: *Mytilus edulis* and *Cerastoderma edule*	Parallel 3a
3	Thijs Frenken	Warming accelerates termination of a phytoplankton spring bloom by fungal parasites	Parallel 1a
4	Rosyta Andriana	Tolerance of benthic diatoms to disturbance along a tidal gradient	Parallel 3a
5	Wu Xiong	Different roles for soil fungal and bacterial communities associated with vanilla Fusarium wilt disease-suppressiveness	Parallel 1a
6	Youk Greeve	Effect of adult bivalves on bivalve recruitment: a positive feedback?	Parallel 3a
7	Shenglai Yin	Migratory geese amplify avian influenza virus infection on their wintering grounds	Parallel 1a
8	Myrna de Hoop	Connectivity affecting critical transitions in drylands: the role of microtopography	Parallel 3a
9	Yasmina Loozen	Remote sensing of canopy N in north-eastern Spain	Parallel 1b
10	Lukas Verboom	Effect of adult bivalves on bivalve recruitment: a positive feedback?	Parallel 3a
11	Judith Sarneel	The Tea Bag Index	Parallel 1b
12	Judith Westveer	habitat fragmentation affects survival and fitness of aquatic macroinvertebrates	Parallel 3a
13	Lisette Bakker	The biodiversity effect: root trait diversity as a driver for overyielding?	Parallel 1c
14	Coline Boonman	Disentangling root distributions of tree species from the savanna-forest transition zone	Parallel 3b
15	Sigrid Dassen	Differential responses of soil bacteria and fungi to plant species richness and composition	Parallel 1c
16	Hamza Issifu	Differential seedling establishment success of congeneric tree species as influenced by woody plant canopy cover in the forest-savanna boundary of Ghana	Parallel 3b
17	Sytske Drost	Clever Cover Cropping: synergistic mixtures for sustainable soils	Parallel 1c

#	Name	Poster title	Relevant session
18	Thomas Janssen	Remote sensing of protected areas: deforestation, forest degradation and woody encroachment	Parallel 3b
19	Stijn den Haan	From genotypic diversity to ecosystem properties: a global comparison of *Zostera marina* meadows	Parallel 1c
20	Sofija Andrić	Additive effects of protozoa on plant growth and nutrient uptake	Parallel 3c
21	Amber Heijboer	Linking microbial diversity to the functioning of soil food webs using Stable Isotope Probing	Parallel 1c
22	Saori Fujii	Differential responses of collembolan species to root-derived carbon	Parallel 3c
23	Huicui Lu	Overyielding in temperate mixed forests during stand development	Parallel 1c
24	Erqin Li	Experimental evolution with natural enemies as a strategy to enhance biocontrol *Pseudomonas*	Parallel 3c
25	Elly Morriën	Soil biodiversity and nutrient cycling in a chronosequence of abandoned agricultural fields	Parallel 1c
26	Haikun Ma	Using plant-soil feedback effects to improve disease control and sustainability in greenhouse cut-flowers	Parallel 3c
27	Carmen Vazquez Martin	SQUASH – a Soil Quality Universally Applicable Soil Health assessment system	Parallel 1c
28	Marta Manrubia Freixa	Plant range expansion effects on soil microbial communities and local decomposition processes in the new range	Parallel 3c
29	Simone Weidner	Effect of serial dilution of soil microbial communities on plant growth	Parallel 1c
30	Kristin Schulz	A fragrant neighborhood: volatile mediated bacterial interactions in soil	Parallel 3c
31	Yi Zou	Agricultural landscapes and pollination services for oilseed rape	Parallel 1c
32	Olaf Tyc	Volatiles in inter-specific bacterial interactions	Parallel 3c
33	Janna Barel	Plant-soil feedback in crop rotation	Parallel 1c
34	Maaike Ave	Rearing conditions of greylag geese affect habitat choice throughout life	Parallel 3d
35	Giulia Bongiorno	Indicators of soil quality for agricultural management	Parallel 1d
36	Elena Valdés Correcher	Variation in herbivore dung quality and its impact on plant species competition	Parallel 4a
37	Maria Hayden-Hughes	The dark knight rises: can the invasive bivalve *Ensis directus* stabilize our coasts?	Parallel 1d
38	Luc De Bruyn	Diet spectrum and preference of the invasive Round goby (*Neogobius melanostomus*) in Flanders	Parallel 4b
39	Marjolein Post	Habitat suitability for juvenile flatfish: consequences of shoreface nourishments	Parallel 1d
40	Mirka Macel	Evolution of invasive plants - a metabolomics approach to shifts in herbivore defenses	Parallel 4b
41	Daphne van der Wal	Foreshore assessment using space technology for cost-efficient flood risk assessment	Parallel 1d

#	Name	Poster title	Relevant session
42	Katrien Van Petegem	Metabolic adaptations underlie life-history evolution in a range expanding arthropod	Parallel 4b
43	Annelies van Ginkel	Tree recruitment: the interplay between tree logs and humans	Parallel 2a
44	Antonella Petruzzella	Biotic resistance strength against invasive aquatic macrophytes in tropical and temperate wetlands	Parallel 4b
45	Shuhang Wang	The infestation process and development of the below-ground cabbage root fly (*Delia radicum*) Larvae	Parallel 2a
46	Hanna ten Brink	Evolution of metamorphosis in species with an ontogenetic diet shift	Parallel 4c
47	Jiaguo Yan	Hydrological connectivity regulates trophic cascade in coastal wetlands	Parallel 2a
48	Hans van Someren Gréve	Behavior as key trait in zooplankton predation risk	Parallel 4c
49	Qiaoli Ayi	Flooding impact disentangled: water pressure affects the survival and growth of the terrestrial plant *Alternanthera philoxeroides* upon complete submergence more than low light or oxygen availability	Parallel 2b
50	Haobing Cao	Chances and changes of salt marsh seedlings establishment in mutable sedimentary world under global change	Parallel 4d
51	Valesca Harezlak	Linking vegetation patterns to floodplain processes	Parallel 2b
52	Joana Frazao	Earthworm communities in relation to arable management in a landscape context	Parallel 4d
53	Marinka van Puijenbroek	Dune development from above: patterns and processes on a natural coast and a mega nourishment	Parallel 2b
54	Luna van der Loos	Macroalgal communities around Sint Eustatius	Parallel 4d
55	Valerie Reijers	How to get rid of reed?	Parallel 2b
56	Peter van Puijenbroek	Fish migration in a European perspective	Parallel 4d
57	Joana Falcão Salles	Unveiling the blueprint of marine-terrestrial transition in bacterial adaptation and evolution	Parallel 2c
58	Floor Soudijn	Predator persistence through variability of resource productivity	Parallel 4d
59	Patrick Meirmans	Where does your bias lie?	Parallel 2c
60	Aoife Sullivan	Human impacts on macroalgae in the Baltic sea	Parallel 4d
61	Wei Zhang	Taxonomy, ecology and phylogeography of the *Brachionus calyciflorus* cryptic species complex	Parallel 2c
62	Stijn van Gils	Interplay of aboveground pest control and nutrient provision from soil organic matter on crop yield	N/A
63	Arne Verstraeten	Increasing dissolved organic carbon (DOC) and nitrogen (DON) levels in temperate forests under acidification recovery and climate change in Flanders	Parallel 2d
64	Anouk Goedknegt	Six roles of parasites in marine invasions	N/A

#	Name	Poster title	Relevant session
65	Yavanna Aartsma	Cultivar attractiveness affects the spatial range of parasitoid recruitment	N/A
66	Laura Seelen	Tapping the power of citizen science	N/A
67	Richel Bilderbeek	What if speciation takes time?	N/A
68	Gerard Korthals / Pella Brinkman	The Centre for Soil Ecology (CSE)	N/A
69	Atiyeh Kashaninia	Environmental stresses affecting *Bemisia tabaci* resistance in tomato plant	N/A
70	Inger de Jonge	Linking biodiversity, ecosystem functions and services in the Serengeti-Mara Region, East Africa: the role of migratory ungulates in improving the resilience of village lands	N/A
71	Viola Kurm	Causes for rarity in the bacterial world	N/A
72	Elvira de Lange	Beating the bugs in the bogs - insect resistance of wild and cultivated cranberry	N/A
73	Yael Artzy-Randrup	Modeling spatio-temporal dynamics of coral disease and its implications for climate change	N/A