NAEM 2014

Netherlands Annual Ecology Meeting

11 & 12 February 2014

Congrescentrum De Werelt, Lunteren

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

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Programme

Tuesday 11 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) • Jaap van der Meer (Chair organising committee, Royal Netherlands Institute for Sea Research)			
	Plenary 1: "Intraspecific body-size dynamics on ecological and evolutionary time scales"			
10:30	1. **Advancing integral projection models for size-structured populations** (Yngvild Vindenes, Centre for Ecological and Evolutionary Synthesis, University of Oslo)			
11.15	2. **Ontogenetic development: the unique, ecological process we tend to ignore** (André de Roos, Institute for Biodiversity and Ecosystem Dynamics, University of Amsterdam)			
12:00	**Lunch in the restaurant**			
	Europe Hall	**America Hall**	**Asia Hall**	**Africa Hall**
13:30	**Parallel 1a:** **Intraspecific body-size dynamics on ecological and evolutionary time scales**	**Parallel 1b:** **Spatial Ecology**	**Parallel 1c:** **Ecology and Macro-evolution**	**Parallel 1d:** **Trophic Interactions**
	Conveners: 1. Anieke van Leeuwen (Princeton University) 2. Isabel Smallegange (University of Amsterdam)	*Conveners*: 1. Sil Nieuwhof (Royal Netherlands Institute for Sea Research) 2. Koen Siteur (Utrecht University)	*Conveners*: 1. Rampal Etienne (University of Groningen) 2. Alex Pigot (University of Groningen) 3. Olivier de Clerck (Ghent University	*Conveners*: 1. Erik Poelman (Wageningen University) 2. Jeff Harvey (Netherlands Institute of Ecology)
13:30	Intra-specific variation in lifetime growth trajectories drives population dynamics of rainforest trees (Pieter Zuidema, Wageningen University)	Surfing on the frontiers of spatial ecology (Johan van de Koppel, Royal Netherlands Institute for Sea Research)	Ecology & Macro-evolution - A new theory of adaptive radiation (Rampal Etienne, University of Groningen)	Multispecies interactions across trophic levels at macroscales: retrospective and future directions (Daniel Kissling, University of Amsterdam)
13:50	Demographic cost of dispersal using the bulb mite (*Rhizoglyphus robini*) as a study system (Jaques Deere, University of Oxford)	Life history trade-offs affect the invasion velocity of spreading plant populations (Monique Lustenhouwer, ETH Zürich)	Phylogenies and the assembly of ecological communities (Alex Pigot, University of Groningen)	Does herbivore identity matter to host searching hyperparasitoids (Feng Zhu, Wageningen University)
14:10	Size-specific predators benefit from seasonal reproduction in their prey (Floor Soudijn, University of Amsterdam)	Revealing patterns of local species richness along environmental gradients with a novel network tool (Mara Baudena, Utrecht University)	Estimating parameters relevant to island biogeography: a new quantitative framework incorporating phylogeny and island ontogeny (Luis Valente, University of Potsdam)	Sweet and tasty: how coping with saline conditions can make plants attractive to herbivores (Wimke Fokkema, University of Groningen)
14:30	Short Break			

	Parallel Session 1 Continued			
14:40	On the evolution of complex life cycles (Hanna ten Brink, University of Amsterdam)	The tragedy of the patterns: evolutionary (mal)adaptation of dispersal through self-organized pattern formation (Monique de Jager, ETH Zürich)	Diversity, diversification and niche evolution of marine macro-algae (Olivier de Clerck, Ghent University)	Mediation of predator-prey dynamics by aquatic plants of varying origin and complexity (Bart Grutters, Netherlands Institute of Ecology)
15:00	Size matters for balancing oxygen supply and demand in aquatic ectotherms (Wilco Verberk, Radboud University Nijmegen)	Resilience at the edge of collapse in salt-marsh ecosystems (Jim van Belzen, Royal Netherlands Institute for Sea Research)	Nature's ecological recorders: stable isotopes in Mycalesine butterflies (Erik van Bergen, University of Cambridge)	Seasonal rock-paper-scissors dynamics drives complex succession in a benthic community (Elisa Benincà, University of Amsterdam)
15:20	Size structure can fundamentally alter natural selection on life history traits (Hal Caswell, University of Amsterdam)	Flock shape, biophysics of movement and local interactions (Charlotte Hemelrijk, University of Groningen)	Extremely high diversity in the Pleurothallidinae (Orchidaceae): phylogeography and pollination biology (Adam Karremans, Leiden University)	Fish-induced changes in prevalence of Cladoceran parasites in subtropical temporary ponds (Silke van den Wyngaert, KU-Leuven)
15:40	**Coffee and tea in the lounge**			
	Europe Hall	**America Hall**	**Asia Hall**	**Africa Hall**
16:00	**Parallel 2a: Enhancing biodiversity for ecosystem-service delivery**	**Parallel 2b: Marine and Aquatic Ecology**	**Parallel 2c: Soil Ecology: What is new and what is next?**	**Parallel 2d: Remote Sensing in Ecology**
	Conveners: 1. Astra Ooms (VU-Amsterdam) 2. David Kleijn (Wageningen University / Alterra)	*Conveners*: 1. Geert Aarts (IMARES) 2. Olga Lyashevska (Royal Netherlands Institute for Sea Research) 3. Eelke Folmer (Royal Netherlands Institute for Sea Research) 4. Jochem 't Hoen (Wageningen University)	*Conveners*: 1. Gera Hol (Netherlands Institute of Ecology) 2. Annemieke van der Wal (Netherlands Institute of Ecology) 3. Simon Jeffery (Wageningen University)	*Conveners*: 1. Thomas Groen (Twente University) 2. Lammert Kooistra (Wageningen University) 3. Anton Vrieling (Twente University)
16:00	Biodiversity conservation, ecosystem service delivery and the role of dominant species (David Kleijn, Wageningen University / Alterra)	Life-cycle connectivity in marine and fresh-water fish species (Karen van de Wolfshaar, IMARES)	Work less and get more insights in the ecological functioning of soils - opportunities offered by the combined use of large molecular frameworks and high throughput, real time PCR-based assays (Hans Helder, Wageningen University)	Hyperspectral time series analysis for detecting invasive tree species in Hawaiian rainforests (Ben Somers, KU-Leuven)
16:20	Plant diversity and nutrient management: key to reducing greenhouse gas emissions from soil (Jan Willem van Groenigen, Wageningen University)	Inter-annual variability in plaice juvenile settlement success due to hydrodynamic conditions (Meinard Tiessen, Royal Netherlands Institute for Sea Research)	From meta-data to soil networks; comparing species interaction between recent and long-term abandoned agricultural field (Basten Snoek, Netherlands Institute of Ecology)	Spectral distances explains higher variance in plant β-diversity than spatial- autocorrelation (Francis Muthoni, Twente University)

16:40	Plant species richness promotes soil C and N storage in grasslands without legumes (Wengfeng Cong, Wageningen University)	Dancing with the tides: fluctuations of coastal phytoplankton orchestrated by different oscillatory modes of the tidal cycle (Anouk Blauw, University of Amsterdam / Deltares)	Are fungal competitive strategies plastic? Exploring fungal-fungal competition between closely related arbuscular mycorrhizal fungal species (Daniel Engelmoer, VU-Amsterdam)	The potential of spectral reflectance: can we "see" the legacy effects of soil from biomass crops? (Sabrina de Carvalho, Netherlands Institute of Ecology)
17:00	Short Break			
17:10	Soil food webs in organically and conventionally managed fields in Iceland and Austria (Jeroen van Leeuwen, Wageningen University)	Agent-based model of Cockle population dynamics in an estuary (Bas Buddendorf, Wageningen University)	Roots at work: root responses to heterogeneity of soil biota (Marloes Hendriks, Radboud University Nijmegen)	Acquisition of Terrestrial LIDAR in tropical forest to support Ecological Research (Harm Bartholomeus, Wageningen University)
17:30	Does soil quality influence the effect of pollinator abundance and aphid infestation on oilseed rape? (Stijn van Gils, Netherlands Institute of Ecology)	Mating in space: amplifier for the outbreak of snake pipefish (Matthias Kloppmann, Thünen Institute of Sea Fisheries)	The promising prospect of promoting soil disease suppression: integrating microbial ecology and substrate chemistry (Angela Straathof, Wageningen University)	Detecting temperature and water stress in plants with Thermal Infrared spectroscopy (Maria Buitrago, Twente University)
17:50	A National Ecosystem Assessment in The Netherlands (Julian Starink, Ministry of Infrastructure and the Environment)	Connectivity between North-Sea colonies fuels rapid population recovery of Dutch gray seal (Sophie Brasseur, Wageningen University)	Tea Bag Index for decomposition (Bas Dingemans, Utrecht University)	Assessing water stress of desert Tamarugo trees by detecting leaf pulvinar movements using remote sensing observations (Jan Clevers, Wageningen University)
18:10	**Drinks in the Lounge and from 18:30 onwards dinner in the restaurant**			
19:30	**Poster session 1 (Odd-numbered posters are presented and discussed) / Coffee**			
	Europe Hall			
21:00	**Evening Programme:** Ruben Smit: The making of "De Nieuwe Wildernis"			

Wednesday 12 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:** **Vegetation – Climate interactions**	**Parallel 3b:** **Ecogenomics: molecular responses to biotic and abiotic stressors**	**Parallel 3c:** **Restoration and Conservation Ecology**	**Parallel 3d:** **Foraging Ecology**
	Conveners: 1. Juul Limpens (Wageningen University) 2. Monique Heijmans (Wageningen University) 3. Milena Holmgren (Wageningen University) 4. Sarian Kosten (Radboud University Nijmegen)	*Conveners*: 1. Nicole van Dam (Radboud University Nijmegen) 2. Koen Verhoeven (Netherlands Institute of Ecology)	*Conveners*: 1. Helene de Paoli (Royal Netherlands Institute for Sea Research) 2. Wouter Suykerbuyk (Radboud University Nijmegen)	*Conveners*: 1. Bart Nolet (Netherlands Institute of Ecology) 2. Sjoerd Duijns (Royal Netherlands Institute for Sea Research)
08:30	Vegetation-climate interactions in terrestrial and aquatic ecosystems (Juul Limpens, Wageningen University)	Adaptation to metal stress: molecular analysis of zinc deficiency and excess tolerance in *Arabidopsis thaliana* and *Noccaea caerulescens* (Mark Aarts, Wageningen University)	Tipping points in restoration: why investing at large enough scale is the key to success (Marieke van Katwijk, Radboud University Nijmegen)	Foraging ecology: ultimate (evolutionary) and proximate (mechanistic) explanations (Sjoerd Duijns, Royal Netherlands Institute for Sea Research)
08:50	Empirical evidence for fast local feedbacks between vegetation, permafrost, topography, hydrology and methane emission in lowland tundra, North Eastern Siberia (Ake Nauta, Wageningen University)	Does epigenetics contribute to adaptation of plants during range expansion? A study on DNA methylation variation in apomictic dandelions in Europe (Veronica Preite, Netherlands Institute of Ecology)	Contrasting responses of two indicators in seagrass beds: Site and Timing effects (Laura Soissons, Royal Netherlands Institute for Sea Research)	Natural selection by pulsed predation: survival of the thickest (Allert Bijleveld, Royal Netherlands Institute for Sea Research)
09:10	Cyclic succession in peat-forming mangroves increases resilience to sea level rise (Joost Keuskamp, Utrecht University)	Horizontal transfer and functional analysis of antibiotic synthesis genes in an animal genome (Wouter Suring, VU-Amsterdam)	Linking species assemblages to environmental change: how specialists became generalists (Michiel Wallis de Vries, Wageningen University / Dutch Butterfly Conservation)	Playing hide and seek: effects of hoarding patterns on risk of pilferage by wild boar (Lennart Suselbeek, Wageningen University)
09:30	Short Break			
09:40	Cyanobacterial blooms effect on water-atmosphere carbon fluxes (Nathan Barros, Radboud University Nijmegen)	Transgenerational effects of an environmental treatment on plant performance in *Arabidopsis* (Maartje Groot, Radboud University Nijmegen)	Experimental evidence that the effectiveness of conservation measures for farmland bird species is determined by resource availability (Martijn Hammers, Alterra)	Why Ruffs feed by day on night-active worms? (Jeroen Onrust, University of Groningen)
10:00	Interacting effects of atmospheric CO2 enrichment and season on the carbon sequestration potential of the aquatic fern *Azolla filiculoides* (Monique van Kempen, Radboud University Nijmegen)	Plant defense in response to multiple insect attack (Anneke Kroes, Wageningen University)	Restoration constraints for aquatic invertebrates of raised bog landscapes: nutrient enrichment and loss of gradients (Gert-Jan van Duinen, Radboud University Nijmegen)	Learning rates for foraging and parasitizing behaviour in a wasp; overall learning ability or task-specific? (Maartje Liefting, VU-Amsterdam)

10:20	Linking fire regimes and climate and biomass burning emissions at different scales in the tropical Andes (Imma Oliveras, Wageningen University)	Analyses of transcriptomic interactions between herbivore-induced responses and water stress in *Solanum dulcamara* (Duy Nguyen, Radboud University Nijmegen)	Restoration groundwork: testing large-scale soil transplantation to facilitate rapid vegetation development on former arable fields (Jasper Wubs, Netherlands Institute of Ecology)	Parasitoid foraging in multi-herbivore communities – does non-host feeding guild matter? (Marjolein de Rijk, Wageningen University)
10:40	**Coffee and tea in the lounge**			
	Europe Hall			
	Plenary 2: "Responsible science: the role of (coastal) ecologists in societal debate"			
11:00	1. **Mutualistic interactions between responsible and theory-advancing science** (Brian Silliman, Marine Conservation Ecology, Duke University)			
11.45	2. **Speak for the worms. How science can inform coastal management** (Peter Herman, Royal Netherlands Institute for Sea Research)			
12:30	**Lunch in the restaurant**			
13:30	**Poster Session 2 (Even-numbered posters are presented and discussed) / Coffee**			
	Europe Hall	**America Hall**	**Asia Hall**	**Africa Hall**
15:00	**Parallel 4a: Responsible Science**	**Parallel 4b: Migration and stopover ecology**	**Parallel 4c: P dynamics in terrestrial and aquatic ecosystems**	**Parallel 4d: Tropical ecology**
	Conveners: 1. Jim van Belzen (Royal Netherlands Institute for Sea Research) 2. Marlies Vollebregt (Wageningen University)	*Conveners*: 1. Adriaan Dokter (Netherlands Institute of Ecology / University of Amsterdam) 2. Raymond Klaassen (Dutch Montagu's Harrier Foundation / Netherlands Institute of Ecology)	*Conveners*: 1. Martin Wassen (Utrecht University) 2. Peter van Bodegom (VU-Amsterdam) 3. Yuki Fujita (KWR Watercycle Research Institute) 4. Harry Olde Venterink (Vrije Universiteit Brussel)	*Conveners*: 1. Lourens Poorter (Wageningen University) 2. Hans ter Steege (Naturalis Biodiversity Center) 3. Joost Duivenvoorden (University of Amsterdam)
15:00	The role of tree-rings in fighting invasive *Anoplophora* outbreaks (Paul Copini, Wageningen University)	New advances in migration and stopover ecology due to novel tracking techniques (Raymond Klaassen, Dutch Montagu's Harrier Foundation / Netherlands Institute of Ecology)	P dynamics in terrestrial and aquatic ecosystems (Martin Wassen, Utrecht University)	The Amazon: Understanding the world's most diverse forest (Hans ter Steege, Naturalis Biodiversity Center)
15:20	Large-scale spatial dynamics of mussel bed coverage in the German and Dutch Wadden Sea (Eelke Folmer, Royal Netherlands Institute for Sea Research)	Tracking red knots to explain differences in gut size and diet choice (Thomas Oudman, Royal Netherlands Institute for Sea Research)	A phosphorus limit for biodiversity in European grasslands? (Tobias Ceulemans, KU-Leuven)	Mycota of understudied biodiversity hotspots – deep DNA sequencing reveals hyperdiverse communities and strong habitat partitioning along altitudinal gradients in cloud forest communities in Borneo and in the Andes (József Geml, Naturalis Biodiversity Center)
15:40	Accounting for soil ecosystem services in agriculture: the optimal policy response (Lia Hemerik, Wageningen University)	Brent Geese fuelling for migration: leisure or overwork? (Adriaan Dokter, Netherlands Institute of Ecology)	P limitation and excess; subterranean blues and joys (Leon Lamers, Radboud University Nijmegen)	Geological change as driver of plant biogeography in Amazonia (Carina Hoorn, University of Amsterdam)
16:00	Break			

	Parallel Session 4 Continued			
16:10	Interacting ecosystem engineers: negative synergistic effects of organic matter loads and lugworm bio-irrigation on seagrass (Laura Govers, Radboud University Nijmegen)	Peeking spring from afar? More accurate timing of migration at higher predictability of phenology along migration routes (Andrea Kölzsch, Netherlands Institute of Ecology)	The other side of the coin – can P-addition alleviate nitrogen stress under nutrient poor conditions? (Christian Fritz, Radboud University Nijmegen)	No evidence for CO2 fertilization of tropical forests over the last century (Peter van der Sleen, Wageningen University / Instituto Boliviano de Investigación Forestal (IBIF))
16:30	Life histories of an invasive and native ladybird under field conditions, do they interact? (Lidwien Raak, Wageningen University)	Opportunistic tracking of food resources in the northern Sahel: plasticity in migratory behaviour of a Palaearctic-African bird species (Rien van Wijk, Swiss Ornithological Institute)	An offshore gradient from phosphorus to nitrogen limitation in the North Sea: A challenge to traditional thought (Amanda Burson, University of Amsterdam)	Do community functional properties predict biomass and productivity of tropical forests? (Marielos Peña-Claros, Wageningen University / Instituto Boliviano de Investigación Forestal (IBIF))
16:50	Mind the gap: managing cross-ecosystem fluxes in the tropical coastal seascape (Lucy Gwen Gillis, Royal Netherlands Institute for Sea Research)	How migrating Honey Buzzards modulate fine-scale flight behaviour as a function of weather conditions encountered en route (Wouter Vansteelant, University of Amsterdam)	Nitrogen versus phosphorus enrichment effects on plant species richness in herbaceous ecosystems (Roland Bobbink, Radboud University Nijmegen)	Forensic forest ecology: unravelling the stand history of tropical forests (Mart Vlam, Wageningen University)
	Europe Hall			
17:20	• **Awards ceremony** o NERN Best Paper Award (Member of the NERN Evaluation Committee) o NecoV Poster Prize (Hanneke Baretta-Bekker, Chair a.i. NECOV) • **Final words** (Louise Vet)			
	Lounge			
18:00	**Farewell drinks**			
18:30	**Dinner and NERN board meeting**			
19:30	**End / Travel Home** (Shuttle available between Conference Centre and Lunteren Station)			

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Presentation Abstracts

Plenary Session 1

Intraspecific body-size dynamics on ecological and evolutionary time scales

Growth and variation in growth due to individual differences and environmental variability gives rise to within-population variation in body size. Because body size determines key life history processes such as reproduction and mortality, the size-structure of a population can drastically influence the dynamics of populations on both ecological and evolutionary time scales. This session focuses on such ecological and evolutionary consequences of the size-structure of populations and the different approaches developed for their analysis.

1. Advancing integral projection models for size-structured populations

(Yngvild Vindenes, Centre for Ecological and Evolutionary Synthesis, University of Oslo)

Integral projection models (IPM) are well suited to study size-structured populations, as individuals are classified according to continuous states. The approach is flexible and data efficient because regression models can be used to estimate vital rates as functions of the trait variable and other covariates (for instance climate variables, population density, or resource availability). Another advantage is that IPMs can be analysed using well developed methods from matrix population models. Over the last decade IPMs have been applied to an increasing number of species and systems, to answer questions related to population dynamics, size structure, and life history strategies. Recent developments link IPMs with quantitative genetics theory, thus providing a promising addition to our understanding of eco-evolutionary dynamics on a contemporary time scale. In this presentation I will give an overview of integral projection models and their applications in ecology and evolution of size-structured populations, with some specific examples from recent studies. I will also discuss the relationship between IPMs and other types of size-structured population models, and some future challenges and opportunities.

2. Ontogenetic development: the unique, ecological process we tend to ignore

(André de Roos, Institute for Biodiversity and Ecosystem Dynamics, University of Amsterdam)

Growth in body size is by far the most prominent aspect of the ontogenetic development that every individual goes through during its life history. Necessarily, development depends on the availability of food and thus indirectly on the feedback from population foraging. Much of our existing ecological theory, however, ignores development altogether and considers population dynamics to be the balance between reproduction and mortality alone. In this presentation I will show that population models accounting for food-dependent growth in body size of individuals make predictions that are in line with our current understanding about population and community dynamics, only if development and reproduction are limited to the same extent by food availability. In contrast, when either development or reproduction is more food-limited than the other process, models that account for food-dependent development make vastly different and very counter-intuitive predictions. For example, it may result in positive relationships between population biomass and individual mortality or allow that a doubly handicapped consumer species, which is ousted by its competitor when competing for resources and in addition is preferentially preyed upon by a shared predator, nonetheless is the only consumer species surviving the predation pressure. I will hence argue that the existing theory about population and community regulation needs to be revised in order to account for the effects of food-dependent ontogenetic development.

Plenary Session 2

Responsible science: the role of (coastal) ecologists in societal debate

During this session we explore the role of ecologists in the societal debate concerning nature conservation and ecosystem services. The keynote lecture concentrate on the coastal zone as a focal area where many societal pressures concentrate spatially: high population density, intense economic activity, threat from climate change and sea level rise. The resulting conflicts are confronting conservation with change, large-scale with small-scale interests, long-time sustainability with short-term interests. In the session we explore the role ecologists can play in the coastal zone and elsewhere, what new methods and concepts are useful and how science can inform and influence decisions.

1. Mutualistic interactions between responsible and theory-advancing science

(Brian Silliman, Marine Conservation Ecology, Duke University)

Current perception among many ecologists is that carrying out responsible science – that science which addresses the immediate needs of society and helps advance human social and economic well-being – comes with a costly trade-off of decreased productivity in theoretical research. In this talk, I present multiple examples of how focusing on responsible science can lead to mutualistic, rather than antagonistic interactions with basic understanding in ecology. In the U.S., coastal ecosystems are simultaneously experiencing increased threat from global change and elevated demand for their valuable services (fisheries production, carbon storage, storm buffering). While working with engineers, social scientists and conservation managers to improve valuation of coastal ecosystem services, shoreline defence, restoration designs, and understanding of massive ecosystem die-off, we have significantly advanced ecological theory. For example, our research has revealed universal mechanisms driving consumer front formation, non-linearity in ecosystem functions, disturbance location as a key driver of large-scale biogeomorphic feedbacks, and distinct functional responses of consumers to increasing stress that fundamentally change our conceptual models of community structure and resilience. The rapidly-changing world and increased government demand that scientist take a more proactive role in solving problems represents an opportunity to discover new theories that can help explain the way earth's systems are evolving. These theories will likely be based in many ways on non-linearity, feedbacks, thresholds and spatially-dependent effects that emerge at large scales. A key component and challenge for increased mutualisms between science and society, however, will be the steadfast adherence to objectivity throughout the scientific and funding processes.

2. Speak for the worms: how science can inform coastal management

(Peter Herman, Royal Netherlands Institute for Sea Research)

All over the world, coastlines are becoming more attractive for people and more dangerous at the same time. Both tendencies are related to global changes in human society and in the earth system. Services delivered by coastal systems, such as transportation, accretion of fertile land, natural ecosystem services and recreation, are balanced by increased risk of drowning due to relative sea level rise and enhanced probability of flooding events. The situation urgently calls for a well-balanced and innovative management of the coast.

Using examples from the extensively managed Dutch coast, I discuss how fundamental management options translate into the ecological functioning of the systems and into the ecosystem services provided by them. I show that some services can be optimized, but usually at the detriment of others. Consequences of these options only become visible at the long term, which poses a planning problem and calls for flexible and reversible solutions wherever possible.

Science can inform management at crucial points, but not by approaching the question as a single optimization problem. Even summary indicators such as 'ecosystem services provided' do not easily lead to a single solution. Scientists have a specific role in the societal debate, but are not in a position to decide. They have to discover and present in the debate what would otherwise remain unrepresented ('speak for the worms'). This poses specific challenges in the case of ecology. Understanding and predicting the future behavior of strongly non-linear systems, as well as finding ways to carefully monitor ongoing tendencies and to influence the system's dynamics at crucial points, are among the most demanding challenges. I will discuss examples of how this knowledge can be developed and applied by different actors in coastal management.

Session 1

1a: Intraspecific body-size dynamics on ecological and evolutionary time scales

Conveners: Anieke van Leeuwen (Princeton University)
Isabel Smallegange (University of Amsterdam)

1. Intra-specific variation in lifetime growth trajectories drives population dynamics of rainforest trees

Pieter A. Zuidema, Eelke Jongejans, Abd Rahman bin Kassim, Hans de Kroon
Wageningen University

Life cycle pathways of individuals in natural populations often vary widely. This individual heterogeneity has important demographic implications, but the consequences for the growth and maintenance of populations are poorly understood. Here we test the hypothesis that fast-growing individuals govern population growth in long-lived species. To this end, we used demographic data of 381,930 trees from a 15-y forest monitoring study in a hyper-rich rainforest in Malaysia. First, we evaluated the effect of deterministic causes of individual heterogeneity by quantifying temporal autocorrelation in diameter growth, i.e. whether some individuals grew persistently faster than others. We found evidence for positive but weak 10-year growth autocorrelation in 77% of the 362 species analysed. We then evaluated the importance of fast vs. slow life cycle pathways to population growth. For 283 species with sufficient recruitment, we constructed Integral Projection Models and performed demographic loop analyses. Overall, fast life cycle pathways contributed five times more to population growth than slow ones. This “fast growth effect” was particularly strong in treelets as in these species fast growth directly increases offspring production. The “fast growth effect” was mostly generated by stochastic variation in tree growth, with a small contribution of growth autocorrelation. Our results show that individual heterogeneity is ubiquitous in tropical tree species and strongly drives tree population dynamics. These findings imply that tree population growth is governed by a small share of the population, with major implications for population management, conservation and demographic modelling.

2. Demographic cost of dispersal using the bulb mite (*Rhizoglyphus robini)* as a study system

Jacques A. Deere, Tim Coulson, Sarah Cubaynes, Isabel M. Smallegange
University of Oxford

Along with births and deaths, dispersal is a key process in determining the dynamics of populations as it affects the size, composition, sex ratio, age structure, social dynamics and genetic composition of populations. Crucially, dispersal has a cost at the individual and population level and there are trade-offs between dispersal capability and life history processes such as growth and survival. Here we assess how dispersal impacts individual life history and population dynamics in the bulb mite (*Rhizoglyphus robini*, Claparède). This species is an ideal study system in that there is a facultative dispersal stage during development. We construct a size- and stage-structured integral projection model (IPM) which tracks the changes in the distribution of body size of females within each life stage through time. From this we calculate population biology parameters (such as stochastic population growth rate (mean fitness) and lifetime reproductive success) and apply sensitivity analyses to assess how these parameters change to perturbations in the model. We do this for a population that includes the dispersal stage in its life cycle and one that does not, thereby directly assessing the effect of dispersal on population dynamics. We find that individuals that go through the dispersal stage have reduced growth and survival, and dispersing individuals decrease population growth rate and lifetime reproductive success when they do not disperse from the natal habitat.

3. Size-specific predators benefit from seasonal reproduction in their prey

Floor H. Soudijn, André M. de Roos
University of Amsterdam

Predators often have a size-specific prey preference. Many biological systems show seasonality and due to seasonal reproduction and growth, a species’ size distribution may vary considerably over the year. Therefore, the food availability of a size-specific predator may vary seasonally. In this study, we tested how a predator was affected by seasonal reproduction in its prey using a stage-structured model. Surprisingly, we found that seasonal variation in the availability of suitable prey items benefits a predator with a preference for small individuals. While for certain environmental conditions the predator cannot persist on a continuously reproducing prey population, it can persist on a seasonally reproducing prey population. The reason for this is, that with seasonal reproduction in the prey, the total biomass of small and large prey individuals oscillates over the season. Small prey biomass decreases beneath the minimum requirements for growth of the predator at times, but the average biomass of small prey over the whole season increases with seasonal reproduction. We found that seasonal reproduction increases the possibilities for coexistence of predator and prey

substantially. The positive effect of seasonality on the coexistence between prey and predator only becomes evident, when the predator's size preference is taken into account.

4. On the evolution of complex life cycles

Hanna ten Brink, André M. de Roos
University of Amsterdam

Approximately 80% of all animal species undergo an abrupt change in their morphology, behaviour or physiology (I.E. a metamorphosis) at some point in their life. It is thought that ontogenetic change in diet was the first step in evolutionary history towards more complex life cycles including metamorphosis. To understand how complex life cycles evolved and why they are so common, it is necessary to understand the evolution of ontogenetic diet shifts. We used an adaptive dynamics approach in a stage-structured biomass model to examine this. We found it is evolutionary advantageous to switch between resources during ontogeny when the different resources require the same morphology. Because changes in morphology resulting in an increase of performance on a resource in one life stage will also affect other life stages, we implemented a trade-off between performances on different diets. We found that a diet shift will only evolve if this does not negatively affect juvenile performance. The selection on the juvenile stage is so strong that in species with a complete diet shift, evolution results in adults that are maladapted to the new resource while their juveniles are well adapted to the old resource. These outcomes suggest that there is strong selection for decoupling of the different life stages such that they can maximize their performance on different resources independently from each other. The evolution of a metamorphosis could be a way to break up the trade-off between performances on different diets between different life stages.

5. Size matters for balancing oxygen supply and demand in aquatic ectotherms

Wilco C.E.P. Verberk
Radboud University Nijmegen

Oxygen is essential for burning food, but may become limiting for organisms relying on gas exchange under water. This is because breathing under water is challenging: the diffusion of oxygen is orders of magnitude lower in water than in air, while the higher density and viscosity of water greatly enhance the cost of breathing. Body size is intimately tied to oxygen budgets through size related changes in oxygen requirements and respiratory surfaces. Hence, oxygen is usually deemed central to explain organisms of gigantic proportions inhabiting cold polar waters with large quantities of dissolved oxygen (polar gigantism). Likewise, giants inhabited the world at a time of a hyperoxic prehistoric atmosphere (Palaeozoic gigantism). Examples of one category of gigantism are often cited in support of the other, but here we present novel insights into the bioavailability of oxygen that imply that they cannot be taken as equivalent manifestations of the effect of oxygen on body size. A novel explanation is forwarded for polar gigantism in aquatic ectotherms, arguing that their larger body size represents a respiratory advantage that helps to overcome the larger viscous forces in water.

6. Size structure can fundamentally alter natural selection on life history traits

Hal Caswell
University of Amsterdam

The evolution of quantitative traits, including life history traits, is governed by the selection gradients on those traits, together with the patterns of genetic variance and covariance. The selection gradients (derivatives of fitness with respect to the traits) can be derived from demographic models, are functions of the environment, and thus provide the crucial link between ecology and evolution. The dependence of mortality, fertility, growth, and development on body size can dramatically alter the sign and magnitude of selection gradients. I will present recent developments that derive selection gradients from models that combine body size with other i-state variables. The models are constructed using the vec-permutation matrix methodology. They distinguish transitions of extant individuals and the production of new individuals by reproduction. Matrix calculus is used to generate selection gradients on any trait as functions of body size and age, and the marginal selection gradients as functions of size or age alone. I will demonstrate how body size alters the selection gradients on age-specific, size-specific, and age x size-dependent mortality and fertility, with reference to the evolution of senescence.

1b: Spatial Ecology

Conveners: Sil Nieuwhof (Royal Netherlands Institute for Sea Research)
Koen Siteur (Utrecht University)

1. Surfing on the frontiers of spatial ecology

Johan van de Koppel
Royal Netherlands Institute of Sea Research / University of Groningen

In this talk, I will highlight recent developments in spatial ecology in the Netherlands and outside, and introduce the speakers that will present their exciting work within this session.

2. Life history trade-offs affect the invasion velocity of spreading plant populations

Monique N. Lustenhouwer, Emily V. Moran, Jonathan M. Levine
ETH Zürich

The spread velocity of invading plant populations depends on seed dispersal ability, fecundity and the age of maturity, according to theory. Plants have evolved a great variety of life cycles and dispersal strategies, and life history theory predicts that there may be trade-offs between dispersal ability and other life history traits. These trade-offs may affect the spread velocity of invading plant populations; both annual species invading an empty landscape by small yearly steps, and far-dispersing tree species taking large steps at longer time intervals, could potentially reach high invasion velocities. We collected data from the literature on the age of maturity, longevity, fecundity, size and dispersal ability of 63 plant species from North and South America, Eurasia and Australia, ranging from herbaceous annual species to trees. The rate at which seed dispersal declines with distance from the parent was used as a direct measure of dispersal ability. We then used a furthest forward individual model of population spread to estimate which combinations of life history traits would lead to the highest spread velocities. Plant height, age of maturity, longevity and fecundity were highly correlated. The dispersal ability of species rapidly increased with the age of maturity. However, while tall, late-maturing species all dispersed very well, there was a large variation in dispersal ability among short, early-maturing species. The fastest spread was found for early-maturing species with sufficiently high seed dispersal. Our results improve our understanding of how life history traits affect the spread velocity of natural plant species.

3. Revealing patterns of local species richness along environmental gradients with a novel network tool

Mara Baudena, Angel Sánchez, Co-Pierre Georg, Paloma Ruiz-Benito, Miguel Á. Rodríguez, Miguel A. Zavala, Max Rietkerk
Utrecht University / Universidad Carlos III de Madrid

We introduce a novel network technique, called the “method of reflections”, to analyse the distribution and richness of species across environmental gradients, and we show that it is an effective tool of analysis of spatial data of species richness. With the method of reflections, we redefined species richness at the local (community) level, including information about inter-species structure, on the basis of network similarities (i.e. community assembly patterns). This technique is notably different from the classical techniques to study species richness at large extent, commonly investigated aggregating local site data to coarser grains, because it keeps the data at the local site scale, but at the same time it includes information from similar communities across the dataset, thus removing noise and identifying outliers in local community data. We applied the method of reflections to a case study, analysing local woody species richness in Spain. We observed that annual precipitation and mean annual temperature explained large parts of the variance of the newly defined species richness, highlighting that, at the local scale, communities in drier and warmer areas were the species richest (as expected from available studies on well-preserved selected local communities). Integrating effectively community structure throughout the dataset and species richness at the local level, our method went beyond what geographical upscaling of the data could unfold, strongly suggesting that the method of reflections is a powerful instrument to detect key factors underlying species richness patterns, and that it could have numerous applications in ecology and biogeography.

4. Evolutionary trapping of dispersal through self-organized pattern formation

Monique de Jager
ETH Zürich

In harsh environments, organisms may survive through the help of close neighbours. Ecological models show that spatially patterned populations shaped by the interaction between local facilitation and long-range competition can persist under otherwise uninhabitable conditions. Most of these studies, however, do not account for the evolution of organismal traits, such as facilitative or dispersal strategies, which can change the organisms’ response to the environment and, subsequently, can alter population dynamics and persistence. Using an eco-evolutionary model, I

show that the evolution of dispersal may result in a maladaptive response to the self-generated environment in a facilitative alpine plant species, leading to extinction at high elevations.

5. Resilience at the edge of collapse in salt-marsh ecosystems

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

Theory suggests that generic early-warnings exist that inform on the loss of resilience when complex natural systems are approaching a tipping point. These early warnings are based on the concept of critical slowing down, which means that the rate of recovery after a small disturbance declines when loss of resilience is looming. Despite the appealing approach suggested by this concept to assess and compare the resilience of real ecosystems, its use is ambiguous: 1) slowing down is not exclusively found in systems that exhibit tipping points and 2) stochastic disturbances can shift ecosystems to alternate states well before recovery is arrested. Here, we present a combined theoretical and empirical study to understand how slowing down can be used to assess and compare the resilience of salt-marsh ecosystems. We show that these ecosystems are still resilient at their edge of collapse. But, resilience at this edge is strongly related to the level of storm-induced exposure to stochastic disturbances. Our study suggests that this relationship only occurs if alternate states are present, highlighting a novel approach for identifying systems exhibiting tipping points. Moreover, this relationship can serve as a benchmark to assess proximity of systems to tipping in stochastic environments.

6. Flock shape, biophysics of movement and local interactions

Charlotte K Hemelrijk, Hanno Hildenbrandt
University of Groningen

Studies of spatial ecology of communities and ecosystems seldom focus at the level of the group. Yet groups are an essential unit of a community. Groups are dynamic in many respects. A remarkable case of such dynamics is the great variation in size, structure and shape of flocks of starlings. At dusk, when manoeuvring above their sleeping site, the size of these flocks varies between two individuals and tens of thousands of them. Also, shapes differ over time within and between flocks, for instance, from wide to oblong from an oval shape to a complex shape and from flat to column-like. Recently many of these patterns have been quantified empirically. What causes this great variation and complexity cannot be understood from empirical data alone. In the present talk we study what causes variation of shapes of flocks of starlings with the help of an individual-based model, StarDisplay. The individuals in the model move, coordinate with their 7 closest neighbours, fly following fixed wing aerodynamics and stay above their sleeping site. The flocking behaviour of the individuals resembles that of empirical data both qualitatively and quantitatively. Experiments in our models demonstrate two main causes of the variation of flock shape: 1) *biophysical constraints* of turning and coordinating during a turn, and 2) *locality of interactions* due to the great numbers of flock members and low numbers of interaction partners. We explain the underlying processes of self-organisation and indicate what empirical data are needed.

1c: Ecology and Macro-evolution

Conveners: Rampal Etienne (University of Groningen)
Alex Pigot (University of Groningen)
Olivier de Clerck (Ghent University)

1. Ecology & Macro-evolution - A new theory theory of adaptive radiation

Rampal Etienne
University of Groningen

I propose a new framework for studying adaptive radiations in the context of ecological limits to diversification, i.e. diversity-dependent diversification. Diversity dependence causes diversification to decelerate at the end of an adaptive radiation but also plays a key role in the initial pulse of diversification. In particular, key innovations (which in my definition include novel traits as well as new environments) may cause decoupling of the diversity-dependent dynamics of the innovative clade from the diversity-dependent dynamics of its ancestral clade, i.e. ecological release. I present a likelihood-based inference method to test for decoupling of diversity dependence using molecular phylogenies. The method, which can handle incomplete phylogenies, identifies when the decoupling took place and which diversification parameters are affected.

2. Phylogenies and the assembly of ecological communities

Alex Pigot
University of Groningen

Ecological communities are assembled over time but the importance of history in explaining the present day structure and diversity of assemblages remains poorly understood. Here we develop a new stochastic framework for modeling the evolution of communities based on phylogenetic data. We demonstrate how these new techniques can help resolve long standing controversies regarding the roles of competition, dispersal and history in the assembly of ecological communities.

3. Estimating parameters relevant to island biogeography: a new quantitative framework incorporating phylogeny and island ontogeny

Luis M. Valente, Rampal S. Etienne, Albert B. Phillimore
University of Potsdam

Islands are excellent model systems for the study of temporal and spatial patterns of diversity. Although phylogenies from island biotas are becoming increasingly available, we still know very little regarding the types of information phylogenetic trees can and cannot provide about the predominant ecological and evolutionary processes that determine community composition on islands. In addition, island biogeography lacks a quantitative framework that would enable the estimation of relevant parameters based on phylogenetic trees of insular taxa. We have developed a new model that fully integrates phylogeny and island ontogeny (the idea that islands have a limited life cycle) into classic island biogeography theory, with the option of including diversity-dependence of rates of species origination. This new framework differs from existing phylogeny-based methods in that its focus is on islands rather than on clades. The model allows us to generate predictions about phylogenetic tree shape and species richness on islands of different ages and with a diverse range of ecological and physical characteristics. In this presentation, I will describe how the model can be applied to phylogenetic data from real island biotas in order to estimate parameters that are relevant to island biogeography, such as island-specific rates of immigration, speciation and extinction. I will also provide a new set of expectations to deal with phylogenetic and phylogeographical datasets from islands.

4. Diversity, diversification and niche evolution of marine macroalgae

Olivier de Clerck
Ghent University

Explaining large-scale patterns of diversity and determining the processes that have generated these patterns is a major goal of evolutionary biologists, ecologists, and conservation biologists. For groups which lack a fossil record, we are entirely dependent on the extant diversity to infer the historical evolutionary processes that resulted in the present-day diversity patterns. Phylogenies, in combination with auxiliary information (e.g. morphology, physiology and ecological traits) and species distributions have the potential to elucidate the evolutionary process. I will present data on diversification of marine macroalgae. Seaweeds provide food and create habitats for a huge number of marine organisms, yet little is known about their evolutionary history and the current day distributions of the individual species. Data availability, e.g. inadequate diversity estimates, geographical sampling bias, uncertainty about phylogenetic relationships and divergence times, as well as methodological issues related to historical biogeography, make that scenarios of macroalgal diversification have rarely been tested explicitly. By integrating parametric models in historical biogeography and ancestral state reconstructions of ecological niches I test the hypotheses that: 1.) the Australian algal flora acted predominantly as a donor region from which species dispersed in the

Cenozoic; 2.) the diversification of typical tropical families is a relatively recent phenomenon coinciding with thermal stratification of the oceans, increased herbivory and tectonic activity in the Oligo-Miocene boundary; 3.) an important element of warm temperate flora's is derived from a tropical flora in response to an increased latitudinal sea surface temperature gradient from the mid-Eocene onwards. I make use of global algal phylogenetic datasets developed over the last decade in my research group and integrate these data with species distribution models and divergence time estimates to explore the evolution of ecological niches.

5. Nature's ecological recorders: stable isotopes in Mycalesine butterflies

Erik van Bergen, Kwaku Aduse-Poku, Oskar Brattstrom, Colin Osborne, Paul Brakefield
University of Cambridge

Mycalesine butterflies have radiated dramatically in Africa, Madagascar and Asia to produce more than 300 extant species. Larval host plants are nearly always grasses. The primary driving process of these radiations could have been the ability of mycalesine butterflies to invade the empty niches that arose as a result of the evolution of the C4 photosynthetic pathway and the world-wide expansion of C4 grasses in open, sunlit environments. Primary forest species of mycalesines are expected to be C3 specialists as the advantage of the C4 pathway declines in shaded forest understories where cool conditions improve the relative photosynthetic efficiency of C3 grass species. In more open habitats we expect mycalesines to be more opportunistic and generalist in their host plant choice or even to have become C4 specialists. Reliable host plant data are essential to be able to test this hypothesis but detailed host plant records for mycalesines are very limited. However, over the last three decades stable isotope analyses have become an important part of the ecologist's toolbox. Here, we used daily trap captures of adult butterflies from a community of three sympatric species of Bicyclus in Malawi to explore whether 13C the 18O values can be used to detect micro-climate conditions during the larval development of Mycalesine butterflies. In addition, we have begun to examine the larval feeding preferences, in terms of C3 and C4 grasses, in a broader phylogenetic-ecological framework. By mapping the data of this large scale isotope survey and the current habitat preferences of Bicyclus butterflies onto the phylogenies we are now able to reconstruct whether one or more shifts to C4 grasses were associated with the colonization of open habitats and subsequent expansions.

6. Extremely high diversity in the Pleurothallidinae (Orchidaceae): phylogeography and pollination biology

Adam P. Karremans, Franco Pupulin, Barbara Gravendeel
University of Costa Rica / Leiden University

The generic and subgeneric classification of subtribe Pleurothallidinae has traditionally been quite a hazardous task. The main challenge being the understanding of the underlying relationships of the morphologically diverse 5000 accepted species in the subtribe. Species groups that could be easily separated from others by means of specific floral traits have been proven to be non-monophyletic using molecular techniques. Undoubtably one of the driving forces behind the high speciation within this group is adaptation to diverse micro-habitats and radiation of species groups in certain areas. Although species belonging to the subtribe are found commonly throughout the American tropics, the species composition is strongly influenced by geography, and environmental conditions in general. Environmental conditions are however not the only factor shaping the phylogenetic picture of these species. Pollinator adaptation is likely to be the driving factor behind the similar morphology in the reproductive organs of unrelated species. Even though the pollination biology of most Pleurothallids remains to be studied, Myophily, or pollination by flies, seems to be common to almost all members of the subtribe. Several obvious morphological traits related with pollination such as anther position and pollinia morphology, which have frequently been used to characterize species groups, are found to have evolved independently in most large species clades within the Pleurothallidinae.

1d: Trophic Interactions

Conveners: Erik Poelman (Wageningen University)
Jeff Harvey (Netherlands Institute of Ecology)

1. Multispecies interactions across trophic levels at macroscales: retrospective and future directions

W. Daniel Kissling, Matthias Schleuning
University of Amsterdam

Antagonistic and mutualistic interactions among multiple species are ubiquitous in nature and their importance for structuring ecological communities has been extensively demonstrated at local spatial scales. However, how local species interactions scale-up to large spatial scales and how they contribute to shape species distributions and diversity patterns at macroecological extents remains less clear. Here, we provide an overview of recent developments in macroecology that take advantage of increasing data availability and new analytical approaches to explore the role of cross-trophic biotic interactions among multiple species at macroscales. Recent studies broadly represent two analytical methods (i.e. analyses of species richness and ecological networks) and provide evidence that plant-animal interactions (e.g. pollination, frugivory) and predator-prey interactions (e.g. as observed in food webs) influence large-scale richness patterns and that ecological network structure varies systematically at macroscales. Current methodological problems and challenges are related to defining the functional links in cross-trophic richness analyses, understanding trait effects in multispecies interactions, and addressing sampling effects when analysing multiple ecological networks across large spatial extents. Key topics for future research are (1) testing paleoclimatic imprints on interaction diversity, (2) understanding macroevolution and the phylogenetic structure of multispecies interactions, (3) quantifying contemporary spatial and temporal variability in complex ecological networks, and (4) predicting novel interactions under global change. Moreover, we see great potential for a deeper bidirectional integration of macroecology and network research, e.g. by analyses of trait complementarity and functional diversity of interacting groups and by employing species distribution modelling to predict changes in functional network structure. Addressing these key topics and achieving a better integration between these two research fields will significantly advance our understanding of the ecological and evolutionary drivers of multispecies interactions. This could also help to develop more realistic forecasts of changes in biodiversity under climate and land use change.

2. Does herbivore identity matter to host searching hyperparasitoids

Feng Zhu, Berhane T. Weldegergis, Jeffrey A. Harvey, Marcel Dicke, Erik H. Poelman
Wageningen University

Herbivore-induced plant volatile (HIPVs) mediated plant-insects interactions have been extensively studied within three trophic levels during last decade. However, food webs generally include four or more trophic levels. Hyperparasitoids are parasitic wasps attacking larvae and cocoons of primary parasitoids which are considered as biological control agents. Our previous study revealed that hyperparasitoids also use HIPVs to locate their parasitoid hosts. And a variation in the attraction of hyperparasitoids to caterpillars parasitized by different parasitoid hosts was observed. In this study, we address additional questions whether the attraction of hyperparasitoids is different when the same parasitoids develop in different caterpillars, using a combination of laboratory and field experiments. We observed higher attraction of hyperparasitoids by HIPVs when plants were infested with parasitized than unparasitized caterpillars under both lab and field conditions. However, the herbivore identity did not affect the attractiveness of HIPVs to hyperparasitoids. The results suggest herbivore identity plays a minor role in HIPV-mediated plant-hyperparasitoid interactions.

3. Sweet and tasty: how coping with saline conditions can make plants attractive to herbivores

Wimke Fokkema, Wendy de Boer, Han Olff
University of Groningen

The salt marshes of the Wadden Sea are an important spring staging habitat for brent geese. Since here brent geese are fattening up before migrating to the north of Siberia for breeding, trophic interactions with the plant species in this habitat are crucial. Brent geese are selective feeders: preferring certain plant species and clearly avoiding others. Up to now quality of plants in terms of amounts of proteins has been proposed as the mechanism behind this. Here, we provide an alternative explanation. Plants on the salt marsh are growing under saline conditions. Therefore these species have to cope with differences in osmotic potential between the environment and the plant cells, which can lead to dehydration. One possible mechanism for this is to accumulate solutes in the cells, to reduce the difference in osmotic potential. These solutes can be salts or organic compounds, like amino acids and sugars. Here, we measured the concentrations of anions (salts), amino acids and soluble sugars in plant species which are preferred or avoided by salt marsh herbivores like the brent goose. Plants which are preferred by brent geese show relatively high

soluble sugar concentrations and low anion concentrations. On the other hand, plants which are mainly using salts to adjust their osmotic potential and only provide low sugar concentrations, are being avoided. In conclusion: we show how the physiological mechanisms plants need to survive under extreme (saline) conditions can shape plant-herbivore interactions by providing an unwanted preference of these species by herbivores.

4. Mediation of predator-prey dynamics by aquatic plants of varying origin and complexity

Bart Grutters, Liesbeth Bakker
Netherlands Institute of Ecology

In aquatic systems plant complexity, structure and biomass are positively correlated to macroinvertebrate biodiversity, possibly through refuge provision and its effects on predation. However, the underlying mechanisms have rarely been studied. Therefore, we investigated the tri-trophic plant – prey – predator interactions in a laboratory study. As non-native plants are commonly found invading ecosystems, and knowledge regarding their ecosystem impact compared to native plants is limited, non-native species were included. Therefore, refuge provision of 14 plants varying in complexity and origin were tested. As macroinvertebrate prey, three distinct macroinvertebrate species were selected: benthic *Gammarus pulex*, pelagic *Daphnia pulex* and plant-associated damselfly larvae. To complete the tri-trophic food web, mirror carp (*Cyprinus carpio carpio*) and dragonfly larvae (*Anax imperator*) were selected as predators. Both predators are common in Dutch aquatic ecosystems, but they have contrasting predation tactics: one is an active hunter while the other ambushes its prey, which hypothetically alters the role of plant refuge. We found that predation was mostly affected by prey behavior and presence or absence of vegetation, while plant complexity and origin had only a subtle impact on predation rates. Additionally, predation rates were higher than our predictions based on literature, which hints at plant rigidity playing a role as prior studies used artificial plants that are commonly rigid. Overall, both native and non-native vegetation might lead to an increased number of macroinvertebrates through the provision of refuge against fish, but community composition is likely shaped through other predator-prey interactions and factors like food availability and oxygen dynamics.

5. Seasonal rock-paper-scissors dynamics drives complex succession in a benthic community

Elisa Benincà, Bill Ballantine, Stephen P. Ellner, Jef Huisman
University of Amsterdam

Nontransitive competition occurs in communities when the competitive abilities of species lack a clear hierarchic structure, as in the well-known children's game of rock-paper-scissors. Theory shows that intransitive interactions can give rise to cyclic succession in communities. Several empirical and experimental studies suggest that intransitive interactions occur in a variety of ecosystems. However, evidence in long term studies is lacking. Here, we present a 20 years long time series of a benthic community, located in New Zealand, in one of the world's oldest marine reserves. The community was characterized by rock-paper-scissors interactions: bare rock was occupied by barnacles and crustose algae, these were overgrown by mussels, and die off of mussels made bare rock available again. These mechanisms generated a complex cyclic succession with irregular species fluctuations that persisted through several generations. Analysis of the species fluctuations revealed a dominant periodicity of about 2 years. These results are supported by a patch-occupancy model, which yielded sustained complex rock-paper-scissors oscillations in the presence of seasonal forcing. These findings provide the first long-term time series of rock-paper-scissors dynamics in a natural community, and support the recent theory that the dynamical complexity generated by nontransitive species interactions may be enriched rather than reduced by seasonal forcing.

6. Fish-induced changes in prevalence of cladoceran parasites in subtropical temporary ponds

Silke van den Wyngaert, Nestor Mazzeo, Koenraad Muylaert, Ellen Decaestecker
KU-Leuven

With a large scale natural field survey in a subtropical temporary pond system we tested how the presence or absence of an important ecological interaction such as fish predation affects parasitism in cladocerans. We selected 8 ponds containing the annual killifish species *Austrolebias viarius* and 6 fishless ponds. Parasite prevalence in three cladoceran species was quantified on a bi-weekly scheme during a three months period. Killifish predation was a strong local selective force structuring the cladoceran host community. Depending on the parasite species, different prevalence patterns were found in relation to the absence/presence of killifish. Unexpectedly, at the end of the season, killifish were replaced by a fish species with a more herbivorous feeding behaviour (*Cheirodon sp.*). This dramatic change in fish community and distribution rapidly induced changes in host population densities and was accompanied by a general increase in parasite prevalence. This study demonstrates the importance of cascading community effects on parasite prevalence patterns in nature. Furthermore it presents the first report on cladoceran endo-parasites and their prevalence in subtropical freshwaters.

Session 2

2a: Enhancing biodiversity for ecosystem-service delivery

Conveners: Astra Ooms (VU-Amsterdam)
David Kleijn (Wageningen University / Alterra)

1. Biodiversity conservation, ecosystem service delivery and the role of dominant species

David Kleijn
Wageningen University / Alterra

Biodiversity conservation is increasingly being justified because of the ecosystem services it delivers. The basic evidence for more diverse ecosystems delivering more benefits comes from experimental studies. Such studies do not consider the costs of maintaining or promoting biodiversity. When costs are taken into account, justifications based solely on ecosystem service delivery could result in optimization rather than maximization of biodiversity conservation. Using wild bee species as a concrete example of an important service providing group, we examine in real world landscapes what proportion of the total species pool is making significant contributions to crop pollination, how this varies in space and time, how common these species are in the wider countryside and how easily they can be enhanced. We examined these issues using existing datasets of bee pollinators from five continents. Across studies, the total number of observed bee species encountered on crop flowers represented less than 13% of the currently known number of species occurring in the countries where our studies took place. An even smaller proportion of species dominated flower visitation rates. Our results indicate that in real-world landscapes the majority of the bee species do not contribute to crop pollination. When crop pollination benefits are the ultimate goal, and costs of maintaining wild pollinators are taken into account, the pronounced dominance on multiple flowering crops of a few easily enhanced bee species across space and time suggests that economically optimal crop pollination requires only a fraction of all bee species. Implications for the rationale for biodiversity conservation are discussed.

2. Plant diversity and nutrient management: key to reducing greenhouse gas emissions from soil

Jan Willem van Groenigen, Diego Abalos, Bandhu Baral, Thom Kuyper, Gerlinde B. de Deyn
Wageningen University

Agricultural soils are the dominant source of the greenhouse gas nitrous oxide (N_2O), ultimately due to increased nitrogen (N) fertilizer use. Although N fertilizer is applied to nurture plants, ecological knowledge of plant species traits has been largely ignored when studying N_2O emissions. Here, we show that the concepts of trait-based ecology and nutrient stoichiometry can help to devise novel N_2O mitigation strategies. In a first study, we tested whether N_2O emissions are dependent on grass species richness and/or species identity. We measured N_2O emissions from monocultures and two- and four-species mixtures of common grass species with different functional traits. We found no relation between plant species richness and N_2O emissions. However, emissions were significantly reduced in specific plant species combinations. The best species mixture depended on the soil nutrient status. Reduced emissions up to 44% in multi-species combinations could be explained by total biomass productivity and by complementarity in root morphology. In a second study, we tested whether Phosphorous (P) availability can affect N_2O emissions through stoichiometric relations with N for maize plants. N_2O emissions decreased by 50% with adequate P fertilization. This could be related to increased plant growth, which reduced soil mineral N concentrations. Novel mitigation strategies may be based on (i) judicious use of non-N fertilizers in order to satisfy stoichiometric relations; and (ii) selection of grass species combinations with traits that are fine-tuned to local N deposition regimes. Our results underline the pivotal role that plant ecology plays in the soil biogeochemical cycle.

3. Plant species richness promotes soil C and N storage in grasslands without legumes

Wengfeng Cong
Wageningen University

Exploring the effect of plant species diversity on soil C and N storage and underlying mechanisms is crucial to understand its potential role in mitigating CO_2 emissions and sustaining ecosystem productivity. So far, the mechanism addressed is the increased soil C and N inputs that were mainly attributed to the presence of legumes, the key functional group. No studies have addressed the pattern and underpinning mechanisms in plant community in the absence of legumes. We investigated soil C and N storage in an 11-year grassland experiment without legumes, and determined accumulative aboveground biomass production, standing root biomass, decomposition of soil organic matter as well as potential soil net N mineralization to mechanistically understand the effects of plant species richness on soil C and N dynamics. We found that plant species richness positively affected soil C and N storage. Greater soil C and N storage was associated with enhanced primary production increased by plant species richness. Plant species richness accelerated the

relative decomposition rate and N mineralization rate of soil organic matter. These findings indicate that plant species richness promotes soil C and N storage through increased primary production rather than through decreased outputs. Increased decomposition of soil organic matter and soil N availability associated with increasing plant species richness suggests a positive feedback to aboveground biomass production. Our results suggest that in the absence of the key functional group (i.e. legumes), plant species richness may still play a role in climate change mitigation and the maintenance of ecosystem productivity.

4. Soil food webs in organically and conventionally managed fields in Iceland and Austria

Jeroen P. van Leeuwen, Taru Lehtinen, George J. Lair, Jaap Bloem, Lia Hemerik, Kristín V. Ragnarsdóttir, Guðrún Gísladóttir, Peter C. de Ruiter
Wageningen University

One of the central hypotheses behind the development of sustainable organic farming is that the soil food web becomes more important in terms of delivering important soil ecosystem functions, such as nutrient mineralisation, suppression of soil borne diseases and soil structure formation. The present study focused on the structure and functioning of soil food webs in organic and conventional farming in two contrasting environments: Iceland and Austria. Organic fields differed from the conventional fields in the absence of artificial fertilizers and pesticide use. At the sites we measured occurrence and abundance of bacteria, fungi, protozoa, nematodes and micro-arthropods. Additionally, we measured the taxa richness and diversity within the group of micro-arthropods. Although total and microbial biomass were higher in organic farms, these differences were not statistically significant. Nematode biomass was higher in organic fields than in conventional fields, while the biomass of omnivorous mites was consistently higher in conventional fields. No differences were found in carbon or nitrogen mineralisation rates between organic and conventional fields. Within the trophic groups though, we found that the organic fields had a consistently higher micro-arthropod taxa diversity compared to conventional fields. These results indicate that the trophic structure and functioning of the soil food webs was not very sensitive to management system, but the taxonomic diversity was. Although the higher micro-arthropod diversity in organic fields did not yield higher ecosystem services such as soil fertility or C sequestration, it implies a higher functional redundancy within the trophic groups of the soil food web is expected to create a higher resistance to disturbances and therefore enhance stability of ecosystem services.

5. Does soil quality influence the effect of pollinator abundance and aphid infestation on oilseed rape?

Stijn van Gils, David Kleijn, Wim van der Putten
Netherlands Institute of Ecology

It is well known that crop productivity is promoted by various ecosystem services like pollination and soil fertility. Enhancing these services could improve food security and minimize adverse side-effects of current agricultural practices on the environment. However, little is known whether and how multiple ecosystem services interact. For example, we do know that both pollination and soil fertility enhance yield, and even that fertilization could lead to higher pollinator abundance in fields, but we do not know whether the effects of pollination on yield are influenced by soil fertility under field conditions. Therefore, in the summer of 2013 we placed pots with oilseed rape (*Brassica napus*) under different soil conditions in a landscape gradient varying in pollinator abundance. We looked whether pollinator abundance, soil organic matter (SOM; proxy for e.g. soil fertility) and nutrient fertilizer have interacting effects on aphid infestation and pod production of oil seed rape. We saw that pollinator abundance, fertilizer and SOM (sub significant) all contributed to pod number, but we saw no interaction effect, suggesting that pollination and soil services act independently to yield. However, we found an interaction between SOM and fertilizer to aphid infestation. Under unfertilized conditions, SOM led to higher aphid infestation rates, whereas SOM led to lower aphid infestation rates under fertilized conditions. Results suggest that the effects of multiple ecosystem services can be both additive and interactive, but do not explain underlying mechanisms. During the presentation we will present results in more detail and speculate on these mechanisms.

6. A National Ecosystem Assessment in The Netherlands

Julian Starink, Ton A.M. Breure, A.C.M. de Nijs, M. Rutgers, M. Thijssen
Ministry for Infrastructure and the Environment

In the national "Implementation Agenda Natural Capital: conservation and sustainable use of biodiversity" actions have been formulated to provide better insights in ecosystems and the services they provide. The agenda is a reaction on the EU Biodiversity Strategy, where EU member states have been asked to provide a national ecosystem assessment before 2020. A major action to be performed is the setting up of a "Digital Atlas of Natural Capital". Biophysical information on natural stocks and the functioning of ecosystems and the services they (potentially) supply, is brought together in this atlas and made accessible to citizens, businesses and governments. Information can be used in planning processes to differentiate between the desired, unwanted and sometimes conflicting activities in an area and to develop a balanced and sustainable site planning. The atlas is

basically a portal with tables, graphs and maps, providing information about the natural capital to citizens, businesses and policy makers. An initial assessment shows that a lot of information is available at the various institutes. The final atlas may contain the ability to zoom in order to facilitate decision-making in the area- and environmental issues. A first operational version of the Atlas will be completed on schedule in late 2014 and will be further developed until 2020. Other actions are a TEEB study to provide data on the economic value of the natural capital, and development of a system to obtain a macroeconomic understanding of the positive and negative effects of economic activities on the quantity and quality of resources, products and services nature provides (Natural Capital Accounts).

2b: Marine and Aquatic Ecology

Conveners: Geert Aarts (IMARES)
Olga Lyashevska (Royal Netherlands Institute for Sea Research)
Eelke Folmer (Royal Netherlands Institute for Sea Research)
Jochem 't Hoen (Wageningen University)

1. Life-cycle connectivity in marine and fresh-water fish species.

Karen van de Wolfshaar, Ingrid Tulp, Geert Aarts, Adriaan Rijnsdorp, Tobias van Kooten
IMARES

The ability to close the life cycle of organisms living in marine and aquatic environments depends on three critical characteristics: habitat requirements, availability, and connectivity between life stage specific habitats. Here we discuss a recently published framework on life cycle closure. This framework will be illustrated with a suit of examples dealing with different aspects of the three critical characteristics. We will highlight differences at spatial and temporal scales and commonalities despite diversity. Persistence of species or (sub-) populations critically depends on maintaining the availability and connectivity of all essential life-stage specific habitats. Hence, a profound understanding of the full life cycle and possible bottlenecks is needed to manage or conserve species.

2. Inter-annual variability in plaice juvenile settlement success due to hydrodynamic conditions

Meinard Tiessen, Theo Gerkema, Piet Ruardij, Henk van der Veer
Royal Netherlands Institute for Sea Research

The life cycle of many marine fish species consists of various life stages: Spawning at open sea, pelagic egg and larval stages and often a juvenile stage bound to shallow water nursery grounds. Numerous studies have demonstrated that pelagic stages appear to be the most critical in determining ultimate recruitment, for example for European plaice (*Pleuronectes platessa*) in the North Sea. Here, we investigated the impact of changing hydrodynamic conditions on pelagic plaice drift and settlement using a coupled numerical model for the years 1994 - 2005. In order to focus on the physical processes, several biological contributions such as behaviour (vertical migration) and mortality were excluded from the simulations. Spawning periods and locations, drift durations, and settlement requirements were selected around known plaice characteristics. Results showed a strong inter-annual variability in the particle drift and settlement. Both the absolute number of settling particles as well as the relative importance of different nursery areas varied over the years, which could be ascribed to dominant wind direction and temperature. Additionally, settlement in the western Wadden Sea showed seasonal changes in the origin of settling particles.

3. Dancing with the tides: fluctuations of coastal phytoplankton orchestrated by different oscillatory modes of the tidal cycle

Anouk N. Blauw, Elisa Benincà, Remi W.P.M. Laane, Naomi Greenwood, Jef Huisman
University of Amsterdam / Deltares

Population fluctuations are often driven by an interplay between intrinsic population processes and extrinsic environmental forcing. To investigate this interplay, we analysed fluctuations in coastal phytoplankton concentration in relation to the tidal cycle. Time series of chlorophyll fluorescence, suspended particulate matter (SPM), salinity and temperature were obtained from an automated measuring platform in the southern North Sea, covering 9 years of data at a resolution of 12 to 30 minutes. Wavelet analysis showed that chlorophyll fluctuations were dominated by periodicities of 6 hours 12 min, 12 hours 25 min, 24 hours and 15 days, which correspond to the typical periodicities of tidal current speeds, the semidiurnal tidal cycle, the day-night cycle, and the spring-neap tidal cycle, respectively. During most of the year, chlorophyll and SPM fluctuated in phase with tidal current speed, indicative of alternating periods of sinking and vertical mixing of algal cells and SPM driven by the tidal cycle. Spring blooms slowly built up over several spring-neap tidal cycles, and subsequently expanded in late spring when a strong decline of the SPM concentration during neap tide enabled a temporary "escape" of the chlorophyll concentration from the tidal mixing regime. Our results demonstrate that the tidal cycle is a major determinant of phytoplankton fluctuations at several different time scales. These findings imply that high-resolution monitoring programs are essential to capture the natural variability of phytoplankton in coastal waters.

4. An agent-based model for the intertidal bivalve *Cerastoderma edule* (L.)

Bas Buddendorf, Richard M. Sibly, Alice S.A. Johnston, Ruth Callaway, Dave Tavner, Stuart Thomas
Wageningen University

The intertidal bivalve cockle *Cerastoderma edule* (L.) is commercially exploited and occurs in estuaries between northern Morocco and the Kola Bay in Russia. In the Burry Inlet, an estuary in South Wales, the cockle population supports one of the UK's largest cockle fisheries as well as an internationally important population of Oystercatchers (*Haematopus ostralegus* (L.)). Since 2002 the

cockle population suffers from unexplained mass mortalities, threatening the continued health and existence of the fishery and of the wading bird populations. There are indications physiological weakness of cockles may play a role. We constructed an agent-based model to study the factors underlying the mass mortalities, and used it to investigate management strategies to see which is most beneficial to the fishery and wading bird populations. Agent-based models (ABMs) use data obtained on individuals, and can be used to study population dynamics, which emerge during simulations, and can be mapped on real landscapes. ABMs are mechanistic and can include the physiological responses of individuals to their external circumstances, including food supply and temperature. The energy budgets of individuals determine their behaviour, and in our model are based on physiological ecology principles. Energy is allocated, in order of priority, to the following processes: maintenance, reproduction and growth. A fundamental difference between our model and dynamic energy budget models is that ours allows for trade-offs in energy allocation to the different processes. Here we present a first version of the model that describes population dynamics over time. Initial output results of the model are promising; the model is able to mimic natural dynamics observed in the field. Moreover, it identifies important knowledge gaps in cockle biology. Lastly, the model parameters may be adjusted to other important bivalve species increasing the reach and usefulness of the model, making it a promising way to study population dynamics of important species in dynamic and changing environments.

5. Mating in space: amplifier for the outbreak of snake pipefish

Matthias H.F. Kloppmann, Cindy van Damme, Jens Ulleweit, Chris P. Lynam, Doug Beare, Bram Couperus
Thünen Institute of Sea Fisheries

Beginning 2004 a massive invasion of snake pipefish, *Entelurus aequoreus*, into waters of the northeast European shelf was observed. This invasion peaked in 2007 and 2008 reaching far up North into the Barents Sea and up to Svalbard. The most puzzling observation was that almost all of these occurrences were pelagic, often far offshore while this species was at the time primarily considered as being coastal. In this study we present data from international surveys. The data indicate a hotspot of first increase of pipe fish abundance south west of Ireland. These data on the outbreak of snake pipefish are being synthesized to test the hypothesis that the snake pipefish outbreak was caused by a local increase of an Irish coastal population in eelgrass beds, followed by a dispersal of specimens to open water in western direction. The density of the pipefish increased exponentially due to an increase of mating encounters in open water facilitated by anticyclonic circulations (*Taylor Column*) above Porcupine and Rockall Bank. After 2004, when the circulation above the banks became less stable due to increased wind stress, specimens drifted to the south and the north, resulting in lower densities and hence reduced or no mating encounters. The evolutionary meaning of the mechanism behind this outbreak is discussed.

6. Connectivity between North-Sea colonies fuels rapid population recovery of Dutch gray seal

Sophie M. J. M. Brasseur, Tamara D. van Polanen Petel, Erik H.W.G. Meesters, Peter J.H. Reijnders, Geert Aarts
Wageningen University

Gray seals were first observed breeding in the Dutch Wadden Sea in 1985. Numbers have grown since then and though much smaller than the colonies in the UK, the colony now forms the largest on the European continent. This study describes the changes in gray seal numbers and geographical expansion in the Dutch Wadden Sea, and elaborates in particular on how this is influenced by temporary and permanent import from other colonies. Counts of hauled out animals were carried out in 1985-2010 during three different periods of the seals' annual cycle; pupping season (November-January), molting season (March-April), and summer (May-September). The local breeding population was estimated using an age-structured population model fitted to pup counts. This is compared to the numbers counted during the annual molt and to the summer count data corrected using haul-out probability estimates derived from telemetry. In 1985 when the first pups were born, initial count of the colony was 40 animals. The numbers have now increased exponentially and seals disperse throughout the Dutch Wadden Sea. The highest pup count occurred in the winter of 2009, when 344 pups were counted. Maximum grey seal counts (all ages) were attained during the molt in 2010 (2,108 seals). The breeding population based on pup counts for that year was estimated at 1742, suggesting that more grey seals use the Dutch Wadden Sea during the moult. Independent data on demographic parameters are still lacking, but the results suggest that there is a regular exchange between Dutch waters and the UK. Young animals from the UK, migrating into the breeding population, results in permanent growth of the breeding population. Also temporary visits, observed during molt and summer, cause substantially higher counts in the Dutch Wadden Sea during summer and molt than estimated for the local breeding population. At present, the factors controlling the rate of exchange are not understood.

2c: Soil Ecology: what is new and what is next?

Conveners: Gera Hol (Netherlands Institute of Ecology)
Annemieke van der Wal (Netherlands Institute of Ecology)
Simon Jeffery (Wageningen University)

1. Work less and get more insights in the ecological functioning of soils - opportunities offered by the combined use of large molecular frameworks and high throughput, real time PCR-based assays

Johannes Helder
Wageningen University

This session is entitled “Soil Ecology: What is new and what is next?”, and my first thought with regard to this question was about the ongoing advantageous shift in time and resources investment from data acquisition to data analyses and interpretation. In the past too often the design of experiments was dictated by practical constraints such as the limited number of samples that can be handled within a given time frame, and boundaries imposed by the scarcity of informative morphological characters that are available for relevant (soil) biota. Molecular approaches often compatible with the handling of hundreds if not thousands of samples, and mostly it allows for a fine tuning till the taxonomic level most appropriate to address the current ecological question. In our case we have built a full-length small subunit ribosomal DNA-based framework from over 2,700 nematode taxa and used this framework for phylogenetic as well as ecological purposes. This framework allowed us to develop qPCR assays for over 70 taxa (at family, genus, and species level), all with the very same optimal annealing temperature. Currently a number of these assays are used for statutory purposes (screening of plant material for quarantine organisms), as well as for soil ecological questions. Three examples will be shown to illustrate the kind of issues that can be addressed by this novel approach. Moreover, I’ll present some ideas about how this could be linked to pyrosequencing-based methods to characterize and monitor soil bacterial and fungal communities.

2. From meta-data to soil networks; a method to tackle large biodiversity databases in ecology

L. Basten Snoek, Elly Morriën
Netherlands Institute of Ecology

Studying soil food webs has taken a huge step forwards by the introduction of high throughput sequencing techniques for micro-organisms. Combined with classical morphological characterization of soil fauna it is possible to create a reliable insight in the present soil biodiversity. In this study, we chose to investigate the soil biodiversity in a land abandonment gradient. Land abandonment is considered an effective tool for restoring biodiversity and ecosystem functions. Thus far little attention is given to the role of soil biodiversity in these systems. Here, we present a method to investigate the soil biodiversity development from a chronosequence of ex-arable fields in The Netherlands. These fields are typically managed by low-intensive grazing while undergoing a transition from an arable system into a species rich grassland. Abandoning agricultural fields triggers a change in the species composition and possibly the way species interact. We were able to reconstruct the full soil food web (from microorganisms to earthworms) at 10 fields that were taken out of production at different points in history. In total ~18000 species were found. The co-occurrence of species at different locations was compared by several network presentations. Using experience from genetics and gene expression work several ways of studying and visualizing meta-data are discussed. The advantages, pitfalls, limitations and statistics of network meta-data analysis will be discussed using examples from our soil biodiversity experiment. This presentation is relevant for a wider audience as similarly large biodiversity databases become more common practice in ecological research.

3. Are fungal competitive strategies plastic? Exploring fungal-fungal competition between closely related arbuscular mycorrhizal fungal species

Daniel J.P. Engelmoer, Jocelyn E. Behm, E. Toby Kiers
VU-Amsterdam

Arbuscular mycorrhizal fungi (AMF) are an important group of soil microorganisms that form a mutualism with the majority of land plants across the world. They not only provide their hosts with important mineral nutrients in exchange for photosynthate, but also can suppress disease and protect against drought. Many studies have focused on the interactions between host and fungi. However, little is known about how AMF compete among themselves. Past studies have found that competitive interactions can lead to dominance of certain species, with the outcome often being dependent on environmental conditions. While most of these studies have been performed on species from different families within the *Glomeromycota*, competitive interactions are likely to be stronger between closely related species. In addition, previous work has tended to focus on competition for host colonization and ignored AMF competition for mineral nutrients in the soil. With the development of species-specific molecular tools, we are now in a position to address these discrepancies. We

investigated the competitive interactions between two closely related AMF species, *Rhizophagus irregularis* and *Glomus aggregatum* by varying nutrient concentrations and tracking changes in their root and rhizosphere colonization strategies. We present evidence that competition strongly reduced overall AMF abundance and competition was the strongest for host (root) versus rhizosphere colonization. Most interestingly, we show that the investment strategy of a species changes in the presence of another species, suggesting that AMF can respond in a plastic manner to maximize their fitness in competitive environments.

4. Roots at work: root responses to heterogeneity of soil biota

Marloes Hendriks, Eric J.W. Visser, Wim H. van der Putten, Hans de Kroon, Liesje Mommer
Radboud University Nijmegen

Plants create soil legacies: a patchy soil, not only heterogeneous with nutrients, but also with specific soil biota. Effects of nutrient hotspots on plant community performance have been studied thoroughly, root responses to patches of different soil biota are to be revealed. Therefore, we performed three short-term experiments in a climate chamber with non-sterilized and sterilized soils and homogeneous and heterogeneous distributions of soil biota within a pot. Plants produced more biomass when growing in sterilized compared to non-sterilized soils. In the latter, productivity was higher when plants were confronted with heterogeneous distributions of soil biota than with homogeneous distributions, while no differences occurred if soil biota were absent. Selective placement of roots in nutrient hotspots thus can lead to higher productivity in soils with heterogeneous nutrient distributions. In our experiment with heterogeneous soil biota, however, differences in rooting placement were small, as the amount of roots was similar in the compartments. Differences between ^{15}N uptake from the different compartments were more pronounced: uptake rates were higher in compartments containing 'foreign' soil biota compared to 'own'. Root activity thus reduces locally as a result of local plant soil feedback. Our studies suggest that patchy soil legacies in grasslands affect nutrient uptake and plant growth and may be one of the mechanisms explaining how diversity effects operate.

5. The Promising Prospect of Promoting Soil Disease Suppression: Integrating Microbial Ecology and Substrate Chemistry

Angela Straathof, Maaike van Agtmaal, Wietse de Boer, Rob Comans, Ellis Hoffland
Wageningen University

Soil microbial ecology plays a pertinent role in food security and, more specifically, in the suppression of harmful soil-borne plant pathogens. Pathogenic microbes are difficult to eradicate but their population dynamics are linked to microbial diversity, activity and, via the latter, substrate (C) quality. The aim is to use soil microbial and chemical parameters to understand processes involved in disease suppression. Here we present research linking pathogen presence and proliferation to total soil community profiles and soil carbon characteristics. An experiment was conducted which expansively characterized 50 arable Dutch soils. Qualification of dissolved soil organic carbon into fractions ranging in bioavailability allowed us to improve predictions of microbial activity (CO_2 respiration) and was conducted in parallel with microbial community profiling (454 Pyrosequencing). In each soil, the growth inhibition of several important pathogens was measured using a novel volatile assay for pathogenic *Rhizoctonia solani*, *Pythium ultimatum*, and *Fursarium oxysporum*. Additionally, a follow-up sugar beet (*Beta vulgaris*) bioassay was conducted with *R. solani* infection in soils amended with different qualities of agricultural C-sources (compost, manure and mineral fertilizer). Results indicate that management practices influencing C turnover are driving the spread of disease in this sandy loam soil. Linking soil microbial ecology with biochemical indicators will allow for more ready detection of pathogenic outbreaks, and potentially inspire management practices of control in susceptible soils. The integration of molecular knowledge of ecological and chemical soil parameters will be critical in optimizing the productivity of soils in the future.

6. Tea Bag Index for decomposition

Joost A. Keuskamp, Bas J.J. Dingemans, Taru Lehtinen, Judith M. Sarneel, Mariet M. Hefting
Utrecht University

We will present a method for collecting comparable, globally-distributed data through crowdsourcing, which has been published in Methods in Ecology and Evolution 2013, 11: 1070-1075. Changes in the balance between soil carbon storage and release can significantly amplify or attenuate global warming. Although a lot of progress has been made in determining potential drivers of carbon release through large-scale decomposition experiments, climate predictions are still hampered by data limitation at a global scale as a result of high effort and measurement costs of comparative litter decomposition studies. We introduce an innovative, cost-effective, well-standardised method to gather data on decomposition rate and litter stabilisation using commercially available teabags as standardised test kits. By using two tea types with contrasting decomposability we can construct a decomposition curve using a single measurement in time. The acquired Tea Bag Index (TBI) consists of two parameters describing decomposition rate (k) and litter stabilisation (S). The method was tested for its sensitivity and robustness in contrasting ecosystems and biomes, confirming that the

Tea Bag Index is sensitive enough to discriminate between these systems. Within an ecosystem, TBI is responsive to differences in abiotic circumstances such as soil temperature and moisture content. The collected k and S values are in accordance to expectations based on decomposition process literature. They are therefore interpretable within the current knowledge framework. TBI can further provide an excellent decomposition reference and has the potential to increase reliability of soil carbon flux estimates based on extrapolations of decomposition data.

2d: Remote Sensing in Ecology

Conveners: Thomas Groen (Twente University)
Lammert Kooistra (Wageningen University)
Anton Vrieling (Twente University)

1. Hyperspectral time series analysis for detecting invasive tree species in Hawaiian rainforests

Ben Somers, Gregory P. Asner
KU-Leuven / VITO

Remote floristic mapping of forests is complicated by the spectral similarity among co-existing species. Here we exploit the potential of imaging spectroscopy, a relatively new sensor technology providing detailed spectral information in the 350-2500 nm spectral domain. We evaluated an alternative spectral unmixing strategy combining a time series of EO-1 Hyperion satellite images and an automated feature selection strategy for detection of invasive tree species in the montane rainforest area of the Hawaii Volcanoes National Park, Island of Hawaii. Spectral information acquired over different portions of the growing season allowed us to capture species-specific phenology, thereby reducing spectral similarity among species. We observed a clear seasonal trend in invasive species detection success when unmixing results were cross-referenced to ground observations; with Kappa coefficients (indicating detection success, 0-1) ranging between 0.66 (summer) and 0.69 (winter) and 0.51-0.53 during seasonal transition periods. An increase of Kappa to 0.80 was observed when spectral features extracted from September, August and January were integrated in the analysis. This approach is sufficiently general and inherently adaptive, thereby supporting species mapping using Hyperion and forthcoming space-borne imaging spectrometers. We further anticipate that management practices in agricultural fields, forests and other natural ecosystems can benefit from this approach. Specific examples are: the monitoring of understory vegetation dynamics and forest species distributions for forest health assessment, biodiversity management and conservation, mapping and characterization of grassland patches in mixed grassland ecosystems (savannas, woodlands, etc.) used to implement fire risk and fire severity control measures and grazing capacity/carrying capacity management.

2. Spectral distances explains higher variance in plant β-diversity than spatial-autocorrelation

Francis Muthoni, Thomas A. Groen, Andrew K. Skidmore, Bert A.G. Toxopeus
Twente University

Most ecosystems lack long-term extensive data that can support analysis of what determines their inherent biodiversity patterns. The spectral variation hypothesis (SVH) suggests that between-plot differences in remotely sensed signal (spectral variation) is a proxy for environmental heterogeneity and therefore can act as an indicator of plant beta-diversity. Spatial process also controls plant beta-diversity patterns. It is unclear how much of variation in beta-diversity that is explained by spectral variation can also be explained by spatial distances and vice versa. We evaluate the potential of spectral variation of Landsat-TM data and spatial autocorrelation in predicting plant beta-diversity in a fragmented landscape. We use Mantel correlograms to investigate the correlation between spectral distances and beta-diversity and the presence of spatial dependency in spectral distances and beta-diversity. We fit a partial least squares regression (PLSR) to predict the variance in the plant beta-diversity explained by spectral and spatial distances and partition the variances due to pure spectral, spatial dependency in spectral distances and purely spatial autocorrelation. Mantel correlograms revealed an exponentially decaying correlation between beta-diversity and spectral distances that was significant between plots with short spectral distances and at the farthest lag distances. Therefore dissimilarity in beta-diversity was lower at shorter spectral distances but increased with increasing spectral distances. We detected significant spatial autocorrelation in beta-diversity and spectral distances suggesting that the variation in beta-diversity was influenced by spatial structure directly and indirectly through spatially dependent environment (spectral distances). The PLSR model explained 37% of total variance in beta-diversity. Both environmental and spatial processes have significant control on beta-diversity patterns in this landscape though the former explained cumulative higher variance (66%) than spatial autocorrelation (34%). This suggests that conservation initiatives should aim at enhancing habitat diversity and increasing the abundance of individual species that would offer more propagules for dispersal.

3. The potential of spectral reflectance: can we “see” the legacy effects of soil from biomass crops?

Sabrina Carvalho, Maarten Schrama, Wim H. van der Putten
Netherlands Institute of Ecology

Worldwide soils are needed to producing food, consumables and bioenergy. The increased pressure on availability of agricultural land, and secondly, intensification of crop production can cause degradation of soil biodiversity and/or function and damage soil ecosystem services. It is therefore

imperative to improve crops management and sustain high quality living soils for future needs. Here we present the effects of different crops on soil nutrient availability, soil biodiversity, soil disease suppressive capacities and study how spectral reflectance of plants can be used to monitor such soil legacy effects. Several experiments were done in greenhouse and field conditions and here we show how different soil managements, from different biomass crops to different organic matter treatments can affect subsequent crop quality (yield and disease resistance) and leaf spectral reflectance. Both biotic and abiotic soil characteristics were measured and the leaf spectral reflectance was done with a contact probe attached to an ASD fieldspec3 field spectrometer. The first results of this study show a strong positive effect of some biomass crops and organic matter content on soil functioning and crop growth, while others increase soils vulnerability to diseases. Leaf spectral reflectance patterns not only support the trend but are sensitive to soil shifts not visible if we evaluate yield alone. The implications for precision agriculture and imagery frequently used indices will be discussed for both crop and natural systems.

4. Acquisition of Terrestrial LIDAR in tropical forest to support Ecological Research

Harm Bartholomeus, Jose Gonzalez de Tanago, Kim Calders, Alvaro Lau Sarmiento, Martin Herold
Wageningen University

LIDAR is seen as a powerful technique for forest research. High resolution point clouds offer great possibilities to study multi aspects of forest ecology, ranging from biomass estimates, stem locations, characterisation of understory to branch architecture and leaf orientation in the canopy. So far, most studies focussed on quite simple forest types with little understory, thus excluding tropical forest. In 2013 we initiated field campaigns to Gabon and Peru, aiming at the systematic acquisition of high resolution terrestrial LIDAR point clouds of a wide variety of tropical forest types. In cooperation with colleagues of Oxford and Leeds we scanned eight 1 hectare Global Ecosystem Monitoring (GEM) plots with a Riegl VZ-400 terrestrial laser scanner. During this presentation we will describe the setup of the measurements, the challenges we faced when scanning in these dense tropical forest types and the solutions we found to overcome these issues. Especially the dense understory caused big challenges, due to occlusion effects, and required a good quality control of the acquired datasets. Our analysis of problems and solutions may help others who plan to acquire comparable datasets in similar types of forest. Further, some first results of the analysis will be presented and we will look forward to some planned analysis. Finally, we would like to discuss how terrestrial LIDAR data can be used to answer ecological questions.

5. Detecting temperature and water stress in plants with Thermal Infrared spectroscopy

Maria F. Buitrago, Thomas A. Groen, Chris A. Hecker, Andrew K. Skidmore
Twente University

Stress in plants generates changes in leaves from decreasing water content to changes in the microstructure and the internal composition of the leave, and changes in the structure of the whole community. Although physiological changes such as water content, relocalization of micro molecules, and macro structural changes such as smaller leaves and canopies are known, the effect of these changes on the thermal properties of plants, and the spectral detection by remote sensors has not been demonstrated yet. This research shows the results of a series of laboratory experiments with an FTIR system (Bruker Vertex70) as a proxy for the remote detection of plant stress in a deciduous and an evergreen species (European beech *Fagus sylvatica* and Rhododendron *Rhododendron sp.*) in the Thermal Infrared (TIR). Four groups of fifteen plants each were separated and treated with cold and warm temperatures (±10°C and 20°C), and poor and well watered conditions. Five leaves of each plant were measured with the FTIR at the beginning and re-measured three months later. These preliminary results show that plants exposed to water and temperature stress have different thermal spectra compared to plants with optimal growing conditions for several sections of the thermal Infrared. Plants under limited water regime showed lower emissivity in regions related to water content (4-6um), but also at longer wavelengths probably associated with adaptations leaf structural traits. Furthermore the evergreen plants (*Rhododendron sp.*) showed less effect to water stress compared to the deciduous plants (*Fagus sp.*), suggesting that *Rhododendron sp.* has more intrinsic resilience to extreme growing conditions.

6. Assessing water stress of desert Tamarugo trees by detecting leaf pulvinar movements using remote sensing observations

Roberto O. Chávez, Jan G.P.W. Clevers
Wageningen University

Tamarugo (*Prosopis tamarugo Phil.*) is an endemic and endangered tree species adapted to the hyper-arid conditions of the Atacama Desert, Northern Chile. Diurnal leaf movements were observed in this Leguminoseae tree species both in the lab and in the field and this had an important effect on canopy reflectance as measured with a radiometer. These movements, common in Leguminoseae species, allow the plants to decrease the direct solar irradiation on the leaves at the hottest time of the day and this way minimize photoinhibition. Since pulvinar movement is triggered by cell water turgor and thus limited for trees under water stress, we hypothesize that the expected changes in

canopy spectral reflectance can be detected by remote sensing and used to assess water stress. A 25 years Landsat time series showed a strong seasonal variation in the normalized difference vegetation index (NDVI) with peak values in winter, which was negatively correlated to solar radiation. This seasonal variation of the NDVI could be explained by pulvinar movement. Trees with water stress exhibited significantly less seasonal variation. An analysis of 10 years MODIS time series showed a positive difference between the NDVI in the morning (Terra satellite) and the NDVI at midday (Aqua satellite), which again could be explained by the pulvinar movement. This difference was smaller for trees with water stress. We conclude that this NDVI difference obtained from the MODIS Aqua and Terra satellites has potential to detect early symptoms of water stress for Tamarugo trees at the stand level.

Session 3

3a: Vegetation-Climate Interactions

Conveners: Juul Limpens (Wageningen University)
Monique Heijmans (Wageningen University)
Milena Holmgren (Wageningen University)
Sarian Kosten (Radboud University Nijmegen)

1. Vegetation-climate interactions in terrestrial and aquatic ecosystems

Juul Limpens, Monique Heijmans, Milena Holmgren, Sarian Kosten
Wageningen University

The effects of global climate change will strongly depend on how vegetation and climate interact. Vegetation responses can both stabilise ecosystems or trigger positive feedbacks that accelerate ecosystem changes. Understanding which effect vegetation responses will have is one of the main research challenges of the future. As an introduction we will frame the session's contributions by placing them in a broader perspective, travelling from the arctic to the tropics and from freshwater to marine. Central will be the big questions concerning vegetation-environment feedbacks that are left unanswered.

2. Empirical evidence for fast local feedbacks between vegetation, permafrost, topography, hydrology and methane emission in lowland tundra, North Eastern Siberia

Ake L. Nauta, Daan Blok, Monique M.P.D. Heijmans, Juul Limpens, Bingxi Li, Bo Elberling, Angela Gallagher, Ko van Huissteden, Roman E. Petrov, Trofim C. Maximov, Frank Berendse
Wageningen University

Arctic tundra ecosystems are warming almost twice as fast as the global average. The increasing temperatures may initiate positive feedback processes between vegetation, permafrost thaw, surface topography and greenhouse gas emissions that have the potential to accelerate arctic warming. In this study we investigated how shrub-permafrost feedbacks interact with geomorphology and hydrology and how these affect the carbon balance in lowland tundra underlain by ice-rich and carbon-rich permafrost in North-eastern Siberia. We experimentally removed *Betula nana* shrub vegetation and monitored permafrost thaw depth, surface topography, hydrology, snow thickness, vegetation and carbon balance since 2007. Within 5 years, shrub removal induced almost doubling of the permafrost thaw depth causing collapse of the surface into concave depressions. The depressions trapped snow and became wet during the growing season, leading to expansion of graminoids and transition from methane sink into methane source. The wetter conditions accelerated permafrost thaw by increasing soil thermal conductivity, resulting in step change in permafrost thaw in the fourth and fifth year. The cascading effects are the first empirical evidence of the positive feedback between vegetation, geomorphology and hydrology in Siberian lowland tundra, one of the world's biggest tundra-areas.

3. Cyclic succession in peat-forming mangroves increases resilience to sea level rise

Joost A. Keuskamp, Ilka C. Feller, Bas J.J. Dingemans, Hendrikus J. Laanbroek, Jos T.A. Verhoeven, Mariet M. Hefting
Utrecht University

Mangroves are an important sink for carbon and nutrients on a global scale. Mangrove forests are encountered in the intertidal zone of the tropics. Species dominance strongly correlates with hydroperiod, so that mangrove forests typically consist of large monospecific patches. Paleo-ecological evidence shows that species dominance is dynamic in time, which is often attributed to catastrophic events. We propose an alternative, autogenic mechanism for cyclic succession patterns in peat-based mangrove systems driven by species-specific differences peat accretion rates. The proposed mechanism is supported by our measurements on peat underlying *Avicennia germinans* and *Rhizophora* mangle stands on Twin Cays, a group of peat-forming islands in Belize. We confirmed that peat underlying inundation-tolerant *Rhizophora* mangle is more recalcitrant and decomposes at a lower rate than peat underlying *Avicennia germinans*, a species which is dominant in areas with a lower hydroperiod. The proposed mechanism implies that species dominance is modified by changes in sea water level such that in periods of relatively rapid sea level rise, the succession may be arrested in the phase where peat-building *Rhizophora spp.* are dominant, while slower peat building species are favoured during periods of relatively slow sea level rise. This succession pattern has important consequences for the resilience of mangroves to sea level rise and is critical for stability of peat-based mangrove ecosystems and their conservation as a carbon sink in the face of a changing climate.

4. Cyanobacterial blooms effect on water-atmosphere carbon fluxes

Nathan Barros, Raquel Mendonça, Vera Huszar, Fabio Roland, Sarian Kosten
Radboud University Nijmegen

Cyanobacterial blooms can alter the carbon balance of inland waters with a still unknown net effect on greenhouse gas emission. On one hand, the high photosynthetic rates enhance the freshwater carbon dioxide (CO2) sink. On the other hand, the intense organic matter decomposition may lead to high CO2 release and, when the sediment becomes anoxic, also to more methane (CH4) production. We measured CO2 and CH4 emissions from a highly eutrophic shallow lake monthly during summer and autumn, over 24 hour periods. The lake was predominantly a net carbon source to the atmosphere. On the few periods when the lake was a CO2 sink, the magnitude of CO2 influx to the water was small. The CO2 diffusive emission at night was higher than during the day due to daytime CO2 uptake by photosynthesis. The same pattern was not found for CH4 diffusive emission, which was high both during the day and night even though CH4 oxidation reduced the CH4 emission in almost 50%. CH4 emission through bubbles was proven highly dependent on temperature and no bubbles were emitted during colder months. In our study lake, CO2 and CH4 production through mineralization in the water column and in the sediment should be offsetting CO2 fixation by primary production. The greenhouse emission from this system can be even higher considering CO2-equivalents. As conclusion, our data confront the usually accepted idea that eutrophic lakes are carbon sinks.

5. Interacting effects of atmospheric CO_2 enrichment and season on the carbon sequestration potential of the aquatic fern *Azolla filiculoides*

Monique van Kempen, Alfons J.P. Smolders, Gerard M. Bögemann, Leon P.M. Lamers, Jan G.M. Roelofs
Radboud University Nijmegen

Azolla spp. occur globally and rank among the fastest growing plants in the world. Although natural *Azolla* stands are usually considered as unwanted aquatic weeds, they may at the same time deliver important ecosystem services as a green fertilizer, a phytoremediation tool and as renewable biomass and animal feed. Concomitant with global climate change, increased atmospheric CO_2 concentrations can be expected to have a strong impact on the biomass production of this fast growing floating fern, although the relative and combined effects of CO_2 enrichment and climate variables may differ with latitude. We therefore investigated the growth of the northernmost occurring species *A. filiculoides* under past (Eocene), present and predicted future CO_2 levels in interaction with temperature and solar radiation. *A. filiculoides* showed a doubling in growth as a result of CO_2 enrichment. However, high temperature and high photosynthetically active radiation significantly lowered its maximum growth potential, presumably as a result of a metabolic shift as indicated by water loss. In addition, nutrient availability and biomass densities significantly regulated growth, and became more important at higher CO_2 levels. Our results show that temperate *Azolla* may become more invasive as a result of future climate change, thereby negatively affecting biodiversity. In addition, our results may serve as a benchmark for potential biomass production and carbon sequestration rates during the massive *Azolla* event in the Eocene, and for the commercial production of *Azolla* in the future.

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

Imma Oliveras, Rosa Maria Roman-Cuesta, Yadvinder Malhi, Liana Anderson
Wageningen University

Global climate models suggest enhanced warming of the tropical mid and upper troposphere, with larger temperature rise rates at higher elevations. Changes in fire activity are amongst the most significant ecological consequences of rising temperatures and changing hydrological properties in mountainous ecosystems, and there is global evidence of increased fire activity with elevation. Whilst fire research has become popular in the tropical lowlands, much less is known of the tropical high Andean region (10°N-20°S, >2000 masl, from Colombia to Bolivia). This study examines remote sensing-derived fire trends in the high Andes at two scales: regional (the entire grassland are of the Tropical Andes) and landscapes (a region of 2.8 m ha in the South-eastern Peruvian Andes). Results suggested a clear climate influence on fire activity, mainly through a sawtooth pattern of precipitation (increased rainfall before fire peak seasons (t-1) followed by drought spells and unusual low temperatures (t0), which is particular common where fire is carried by low fuel loads (e.g. grasslands and fine fuel). This climatic sawtooth appeared as the main driver of fire trends, above local human influences and fuel build-up cyclicity. At the local scale, however, fire dynamics showed a large intra- and inter-annual variability, with most fires occurring May-October (the period coinciding with the dry season). Total area burned decreased with increasing rainfall until a given rainfall threshold beyond which no relationship was found. The greatest contribution (60-70%, depending of the data source) to biomass burning emissions came from burned montane cloud forests (4.5 million Mg CO_2 over 2000-2011), despite accounting for only 7.4-10% of the total burned area. Gross aboveground biomass emissions (7.55 ± 2.14 Tg CO_2; 0.43 ± 0.04 Tg CO; 24,012 ± 2,685 Mg CH_4 for the study area) were larger than previously reported for the Tropical Andes.

3b: Ecogenomics: molecular responses to biotic and abiotic stressors

Conveners: Nicole van Dam (Radboud University Nijmegen)
Koen Verhoeven (Netherlands Institute of Ecology)

1. Adaptation to metal stress: molecular analysis of zinc deficiency and excess tolerance in *Arabidopsis thaliana* and *Noccaea caerulescens*

Ana Carolina Atala Lombelo Campos, Yanli Wang, Edouard Severing, Ya-Fen Lin, Ross Alexander, Mark G.M. Aarts
Wageningen University

Plants need zinc (Zn) as an essential micronutrient for many cellular processes, and like all other organisms, they evolved a regulatory system to control the plant and cellular Zn status, ensuring Zn homeostasis. We use two model species to study regulation of Zn homeostasis in plants, *Arabidopsis thaliana*, the well-known plant model species, and *Noccaea caerulescens*, a Zn/Ni/Cd/Pd hyperaccumulator of the same Brassicaceae family. In a screen for natural genetic variation for response to Zn deficiency, we screened a collection of ~350 natural *A. thaliana* accessions and identified two accessions with extreme and contrasting phenotypes for Zn deficiency tolerance. These accessions, and the reference accession Col, have been used for RNA-Seq transcriptome analysis. Thus, several genes have been identified to be either involved in the *A. thaliana* core response to Zn deficiency, or in the accession specific Zn deficiency response. The same screen, in combination with elemental analysis of accessions, has been used for a Genome Wide Association Study. This revealed many candidate loci involved in the (adaptive?) response to Zn deficiency. While *A. thaliana* represents the vast majority of Zn excess sensitive species, *N. caerulescens* is one of the best studied species to represent the rare class of metal hyperaccumulator species, which have evolved extreme adaptation to heavy metal exposure (mainly Ni and Zn). We have identified several different populations classified to one of the four ecotypes that are distinguished: non-metallicolous, Zn hyperaccumulating calamine, Zn/Cd hyperaccumulating calamine and serpentine. Non-metallicolous and Zn hyperaccumulating calamine populations have been sampled and subjected to population re-sequencing in order to try and identify loci subjected to selection. Preliminary results of this analysis will be discussed.

2. Does epigenetics contribute to adaptation of plants during range expansion? A study on DNA methylation variation in apomictic dandelions in Europe

Veronica Preite
Netherlands Institute of Ecology

Greenhouse experiments with apomictic dandelions showed that exposure to biotic and abiotic stressors triggered changes in DNA methylation and this “stress memory” was partly passed on to the next generation. But so far it is not clear if, or how much, heritable epigenetic variation contributes to adaptation in natural populations. Adaptation to novel environments is important for colonizing new habitat and hence also important for species range expansion in response to climate warming. Asexually reproducing dandelions (*Taraxacum officinale*), that colonized Northern Europe after the last glaciation, provide a good study system to test epigenetic variation in natural populations. These dandelions reproduce through apomixis, thus asexually but via seeds, and therefore lack the variation-generating mechanisms of recombination and segregation that facilitate genetic adaptation in sexuals. The fine-tuning and the heritability of gene expression variation via DNA methylation might have facilitated the migration of apomictic lineages towards north. To test the potential role of DNA methylation variation during range expansion we collected seeds from apomictic dandelions along a latitudinal transect in Europe. We present an analysis of genetic and epigenetic variation (method: AFLPs and methylation sensitive AFLPs) within and among the populations occurring along this transect. Our hypothesis is that these populations are epigenetically differentiated. More specifically, patterns of methylation variation that are uncoupled from patterns of genetic variation may hint at an adaptive role of DNA methylation in asexual range expansion.

3. Horizontal transfer and functional analysis of antibiotic synthesis genes in an animal genome

Wouter Suring, Valeria Agamennone, Bram Brouwer, Nico van Straalen, Wilfred Röling, Dick Roelofs
VU-Amsterdam

Soil toxicity is often determined using the springtail *Folsomia candida* as an indicator species. Toxicogenomics studies in our lab are used to link the ecological effects of soil toxicity to transcriptomic responses in *Folsomia candida*. During exposure to practically any pollutant that has been tested (cadmium, zinc, phenanthrene, etc.) two genes that are part of the penicillin biosynthesis pathway are upregulated in this springtail. This is remarkable because until now, the penicillin biosynthesis pathway was only known to exist in some fungi and bacteria. We have sequenced the entire *Folsomia candida* genome and confirmed that these genes are in the springtail’s genome and were not found due to bacteria or fungi in our samples. In situ hybridization showed that the first gene of the penicillin biosynthesis pathway (ACV synthase) was expressed in gut

epithelial cells in Folsomia. Next, we tested one of these gene products (isopenicillin N synthase) for in vitro activity and found that recombinant FcIPNS was able to catalyze the formation of isopenicillin N from its substrate. This suggests that this springtail may be able to produce a beta-lactam antibiotic like penicillin, which is the current focus of our research. Here, I will present the expression during stress, genomic context and functionality of the two penicillin biosynthesis pathway genes in *Folsomia candida*'s genome.

4. **Transgenerational effects of an environmental treatment on plant performance in Arabidopsis**

Maartje P. Groot, Rik Kooke, Joost J.B. Keurentjes, Nieke Knoben, Philippine Vergeer, N. Joop Ouborg, Koen J.F. Verhoeven
Radboud University Nijmegen

Transgenerational stress memory allows offspring of exposed plants to react more quickly and adequately when they encounter the same stress. Growing evidence suggests that such effects may be mediated through epigenetic mechanisms and can persist for multiple generations. However, it is largely unknown how common transgenerational effects are and whether they play a relevant role under natural conditions. In our research we exposed Arabidopsis Col-0 plants for three consecutive generations to a salt treatment or control environments, in a factorial design with all possible combinations of G1, G2 and G3 environments. Offspring was evaluated in a growth chamber under salt treatment and control conditions and in a common garden field experiment. We measured fitness related traits of the offspring and found differences between offspring from salt treated plants and offspring from control plants. These differences were found in both environments; only the expression of the effect differed strongly between environments. In some traits we found differences even when only (great-) grandparental plants were exposed to salt stress. Furthermore in the growth chamber offspring from plants exposed to multiple generations of salt treatment did not show a cumulative negative effect. While in the field offspring from plants exposed to multiple generations of salt responded the same as offspring from control treated plants. These results indicate that offspring from plants exposed to an environmental factor showed differences in fitness related traits when compared to offspring from control treated plants, and this effect persisted longer than a single generation. Also the effects on the offspring differed between environments. Our study demonstrates that an environmental treatment in previous generations may have an influence on offspring performance and that environment plays a major role in these processes.

5. **Plant defense in response to multiple insect attack**

Anneke Kroes, Joop van Loon, Marcel Dicke
Wageningen University

In nature, plants are exposed to attacks by multiple herbivore species at the same time. To cope with these attacks plants have evolved complex defences response mechanisms. Interactions between responses to multiple insect attackers could affect the timing and intensity of plant defences which may result in either facilitation or suppression. This study investigates the underlying regulatory mechanisms that initiate plant defences to multiple attackers. We analysed how different *Brevicoryne brassicae* aphid densities interfere with induced defences against *Plutella xylostella* caterpillars in *Arabidopsis* plants. At a density of 5 aphids per plant, growth rate of *P. xylostella* was increased, whereas its growth rate was reduced on plants simultaneously infested with 25 aphids. Presumably aphids interfere with the SA signal-transduction pathway since caterpillars feeding on the *sid2* mutant, which fails to accumulate SA, were not affected by the presence of aphids. Furthermore, growth of caterpillars was affected on plants in which the SA response was stimulated with increasing concentrations of SA. Transcriptional analysis revealed that expression of *WRKY70,* an activator of SA-dependent defence genes*,* was up-regulated in plants simultaneously attacked by caterpillars and 5 aphids whereas in plants simultaneously infested with caterpillars and 25 aphids expression of *WRKY70* is suppressed. This study demonstrates that multiple insect attack affected plant defences in a density-dependent manner. Moreover, our data show that the SA signal-transduction pathway is required for aphid interference with induced defences against caterpillars.

6. **Analyses of transcriptomic interactions between herbivore-induced responses and water stress in *Solanum dulcamara***

Duy Nguyen
Radboud University Nijmegen

Plants are subject to multiple biotic and abiotic stresses in their natural habitats. Understanding the interactions of their molecular responses to these multiple stressors would give essential insights into the mechanisms behind plant adaptation to changing environments. *Solanum dulcamara*, which was found to have great adaptability to wide range of habitats (from dry sand dunes to waterlogged lake borders) and to be the host of diverse insect herbivores, is developed as a new model species for these purposes. In this study, we used RNA sequencing technology to investigate the transctiptomic interactions of plant responses to water-related stresses (drought and waterlogging) and insect herbivory by the generalist *Spodoptera exigua*. Our results indicate that drought stress and insect

herbivory induced more genes than waterlogging. More interestingly, almost one third (32.3%) of the drought-induced genes were also induced by insect herbivory, but for waterlogging-induced genes there was only 13.5% overlap. Gene set enrichment analyses showed that the group of induced genes shared between drought stress and insect herbivory indeed includes many genes involved in insect-induced hormonal responses, in defense responses such as respiratory burst or protease inhibitor activity, or in biosynthesis of possible defensive secondary metabolites (alkaloids, flavonoids, terpenoids). These findings could explain the result that *S. exigua* gained less weight when feeding on *S. dulcamara* plants under drought stress compared with the ones feeding on plants under waterlogging. This study suggests that drought stress may prime the plant to be more resistant against insect herbivory, whereas plants under waterlogging may become less resistant against insect herbivory.

3c: Restoration and Conservation Ecology

Conveners: Helene de Paoli (Royal Netherlands Institute for Sea Research)
Wouter Suykerbuyk (Radboud University Nijmegen)

1. Tipping points in restoration: why investing at large enough scale is the key to success

Marieke M. van Katwijk, Kate O'Brien, Nuria Marbà, Robert J. Orth, Carlos M. Duarte, Gary A. Kendrick, Anitra Thorhaug, Marten Scheffer
Radboud University Nijmegen

Many ecosystems display bistability with a preferred (reference) state and a non-preferred (degraded) state. Preserving or restoring ecosystems to the preferred state is a primary goal for environmental conservation managers. Tipping points occur when a small change in conditions undermines the self-facilitation processes which maintain the system in a favourable state. For restoration to the preferred state, the feedbacks which maintain the adverse state need to be overcome, through perturbing the system (e.g. replanting) and/or improving conditions to the tipping point for recovery, usually quite different from tipping points for collapse. To trigger recovery, conditions can be improved permanently, or windows of opportunity can be created or found. However, the complex, non-linear interactions between deterministic and stochastic processes mean that tipping points are difficult to predict and will vary over time and space. Restoration of degraded ecosystems must be undertaken on a sufficiently large scale to increase the likelihood of (1) reaching the critical threshold required to initiate self-facilitation processes which will further the restoration, and (2) encountering a window of opportunity or spread risks in time or space. Analysis of worldwide seagrass restoration success as a case study confirms the importance of restoration scale.

2. Contrasting responses of two indicators in seagrass beds: Site and Timing effects

Laura M. Soissons, Baoquan Li, Qiuying Han, Marieke M. van Katwijk, Tom Ysebaert, Peter M.J. Herman, Tjeerd J. Bouma
Royal Netherlands Institute for Sea Research

Despite being a highly valuable key-stone ecosystem, seagrass meadows are threatened and declining worldwide, creating urgent need for indicators of their health status. We compared two indicators in their capacity to estimate seagrass health: Standing leaf area index as a direct indicator of health versus Relative recovery from local disturbance by removing aboveground biomass as an indirect indicator for health in terms of resilience. With a series of manipulative field experiments, we investigated the effect of site exposure (exposed vs. sheltered site), contrasting nutrient stress levels, and timing of the disturbance on the strength of response of both indicators. We observed an opposed response between the two indicators, as nutrient enrichment increased standing cover while decreasing the relative recovery, an indicator of resilience. Timing of the disturbance over the growing season has a major effect on resilience, with highest recovery at the start of the growing season, and a decreasing recovery with higher cover. Our results emphasize the importance of considering timing in the evaluation of seagrass resilience in temperate systems. Therefore, the seasonality of seagrasses and the timing in which the effect of disturbances on resilience are assessed are essential for management and conservation purposes.

3. Linking species assemblages to environmental change: how specialists became generalists

Michiel F. Wallis de Vries
Wageningen University / De Vlinderstichting

Environmental changes due to developing land use, climate change and nitrogen deposition have profound influences on species assemblages. Investigating the dynamics in species composition as a function of underlying traits may increase our understanding of ecosystem functioning and provide a basis for effective conservation strategies. Here, I use a broad array of species traits for butterflies to identify four main components of associated traits. These reflect the spatial use of the landscape, abiotic vulnerability, phenology and developmental rate, and food specialisation, respectively. The first three trait components each contribute to determine Red List status, but only the phenology and developmental rate component is related to recent population trends. I argue that the latter component reflects the environmental impact of nutrient availability and microclimate, as affected by nitrogen deposition. This perspective sheds a new light on ongoing changes in community composition. In particular, it reveals that, in the pre-industrial landscape, species currently regarded as generalists formerly were specialists and former generalists have become specialists. Thus, a multidimensional view of trait associations allows us to move beyond the simplistic specialist-generalist dichotomy, renew our view on species-specific studies and help in setting new priorities for conservation.

4. Experimental evidence that the effectiveness of conservation measures for farmland bird species is determined by resource availability

Martijn Hammers, Gerard Müskens, Ruud van Kats, Wolf Teunissen, David Kleijn

Alterra

The intensification of agriculture is the main cause of the decline in abundance and diversity of farmland species. Large-scale conservation programs have been enforced to halt these declines. However, the effectiveness of conservation measures may differ dramatically between locations and the species considered. Conservation efforts usually aim to enhance the availability of key resources limiting population growth. These conservation efforts are expected to be most effective when they create a large contrast in resource availability compared with the baseline situation. Indeed a recent meta-analysis suggested that the magnitude of the contrast in resource availability created by conservation measures is the key factor explaining their effectiveness. However, we are unaware of any other studies that tested this “ecological-contrast hypothesis”. Here, we examine the behavioural responses of granivorous farmland birds to experimentally increased resource abundance in winter along a gradient in resource availability. One of the key components of habitat quality for granivorous farmland birds in winter is seed availability. Therefore, winter habitat quality may be assessed by measuring seed availability and may be improved experimentally by supplementing seeds. We found that (experimentally increased) resource availability explains the abundance and diversity of farmland birds in winter and provide support for the ecological-contrast hypothesis.

5. Restoration constraints for aquatic invertebrates of raised bog landscapes: nutrient enrichment and loss of gradients

Gert-Jan van Duinen
Radboud University Nijmegen

Raised bog landscapes are degraded by loss of natural gradients between bog massifs and surrounding minerotrophic landscapes, peat extraction, and nutrient enrichment. To restore degraded bogs rainwater is retained, aiming at Sphagnum recovery. We hypothesized that nutrient enrichment enables aquatic macroinvertebrates absent from pristine bog massifs to become abundant in nutrient enriched bog remnants. Our second hypothesis was that macroinvertebrates characteristic of bog gradients hardly profit from restoration focusing on ombrotrophic conditions solely. Macroinvertebrate abundance was higher in bog remnants in the Netherlands, where nitrogen and phosphorus concentrations are increased, than in pristine bog pools in Estonia. This increase was indeed primarily due to species absent from unpolluted ombrotrophic bog pools. In pools created by restoration the abundance of species preferring nutrient poor ombrotrophic pools was higher than in pools remaining after historical use of bogs, such as peat cuttings. The cumulative richness and abundance of species preferring minerotrophic parts of bog gradients were decreased in Dutch bog remnants. Further reduction of nitrogen and phosphate availability in bogs and restoration of transitional habitats in and adjacent to remaining bog remnants, as well as in fen reserves currently including relict populations of species typical for bog gradients is recommended.

6. Restoration groundwork: testing large-scale soil transplantation to facilitate rapid vegetation development on former arable fields

E. R. Jasper Wubs, Wim H. van der Putten, T. Martijn Bezemer
Netherlands Institute of Ecology

Restoration of ex-arable fields to semi-natural grasslands is an important method for counteracting biodiversity loss in northwestern Europe. This is a long process that may take decades or longer. High nutrient availability and lack of an appropriate seedbank are well-known restoration bottlenecks. However, recently it has been shown that the soil community also plays a crucial role in driving the secondary succession on ex-arable fields. Yet an explicit belowground perspective in nature restoration has so far not been applied in practice. Here we report the first field experiment transplanting soil communities from well-developed nature areas to a new restoration area performed at a spatial scale relevant for restoration practice. In 2006, transplantation of both soil from a species-rich grassland and sods from a heathland were carried out in four replicate areas (2.5-5 ha) on an ex-arable field. To compare with conventional restoration measures hay was spread over similar areas and these treatments were executed both on the original soil as well as on areas where the top-soil had been removed. After six years the restoration success was evaluated by quantifying vegetation structure and composition in 1x1m plots. Furthermore, fungal, bacterial, nematode and microarthropod abundance and composition, as well as edaphic factors were measured in each plot. We show that the transplantations, particularly using sods - has increased plant cover in top-soil removal areas and promoted plant diversity in general. This suggests that soil transplantation may be an effective measure to jump-start the restoration of species-rich vegetation on former arable fields.

3d: Foraging Ecology

Conveners: Bart Nolet (Netherlands Institute of Ecology)
Sjoerd Duijns (Royal Netherlands Institute for Sea Research)

1. Foraging ecology: ultimate (evolutionary) and proximate (mechanistic) explanations

Sjoerd Duijns
Royal Netherlands Institute for Sea Research

This opening session concerns ultimate (evolutionary) and proximate (mechanistic) explanations of observed foraging behaviour. Foraging ecology has indeed moved up, down and sideways as the different speakers of this session will show. In this general introduction we will highlight the different aspects of foraging, thereby focusing on the effect on prey (Bijleveld), the behavior of prey (Suselbeek), as well as the mechanisms to find prey (Onrust), learning (Liefting) and proximate explanations of food finding (De Rijk). Examples of our own work on shorebirds will be used to introduce the different topics.

2. Natural selection by pulsed predation: survival of the thickest

Allert I. Bijleveld, Sönke Twietmeyer, Julia Piechocki, Jan A. van Gils, Theunis Piersma
Royal Netherlands Institute for Sea Research

Predation invokes natural selection by selective prey removal, but also alleviates competition between surviving individuals via density-dependent processes. Both processes can have substantial effects on prey population dynamics. Nevertheless, studies quantifying both have remained rare. In this experimental field study, we report of density dependence in cockle prey (*Cerastoderma edule*), and the selection pressures invoked by red knot predation (*Calidris canutus*). We measured spatial distributions of densities, and phenotypic traits of cockles, before and after predation by red knots in three plots of 1 ha, of which two were predated, and one served as a control. We found that the size-corrected flesh content and shell mass of cockles declined with their density, and that, before predation, cockles were patchily distributed. After predation, the spatial distribution of cockles was homogenized and average densities were reduced by 71% (from 248 m^{-2} to 71 m^{-2}) and 79% (from 350 m^{-2} to 75 m^{-2}). Red knots specifically selected small cockles (6.9 mm SD 1.0) and those cockles that survived predation had 29% heavier shells indicating that knots created a selection pressure for cockles to incorporate heavy shells. The reduction in cockle densities alleviated intraspecific competition possibly allowing for increased growth necessary to escape predation.

3. Playing hide and seek: effects of hoarding patterns on risk of pilferage by wild boar

Lennart Suselbeek, Vena M.A.P. Adamczyk, Frans Bongers, Bart A. Nolet, Herbert H.T. Prins, Sipke E. van Wieren & Patrick A. Jansen
Wageningen University

Food hoarding patterns range between larder hoarding (few large caches) and scatter hoarding (many small caches). Animals that scatter hoard are believed to do so, despite higher costs, to reduce loss of cached food to competitors against which they cannot defend their food reserves (henceforth; superior competitors). We tested the underlying assumption that the increased likelihood of superior competitors to encounter (more abundant) caches is outweighed by their reduced ability to detect (smaller) caches once encountered. We carried out a controlled experiment in which we distributed a fixed number of acorns over a fixed number of patches within a fixed area, varying cache size and cache depth, thus mimicking alternative hoarding patterns. We then recorded cache pilferage by a fixed number of wild boar (*Sus scrofa*), a reputed pilferer of acorn caches. The time wild boar needed to pilfer the first cache was shortest for scatter hoarding, but the time needed to pilfer all caches was slightly longer for scatter hoarding than for larder hoarding. Overall, however, pilferage rates did not differ between scatter hoarding and larder hoarding and was not affected by cache depth. We conclude that the effect of alternative hoarding patterns on reducing cache pilferage by wild boar were much smaller than expected and that superior competitors may thus not be such important drivers of scatter hoarding. Instead, other factors, such as conspecific pilferage or cross-contamination of food in large caches, which can also cause catastrophic loss of food reserves, may be more important drivers of scatter hoarding.

4. Why Ruffs feed by day on night-active worms?

Jeroen Onrust
University of Groningen

During migration Ruffs make use of agricultural grasslands to prey upon earthworms. However, little is known about the foraging behaviour of this shorebird species. In this study we observed earthworm-eating Ruffs in the field and under controlled conditions with captive birds. Fieldwork was conducted in Southwest-Friesland during spring migration in 2011. Intake rates were scored by observing individual Ruffs at different grasslands. At the same grasslands, available earthworms were counted by using a newly developed cart on which the observer lies and counts the worms that are active at the surface. Earthworms were counted during daytime when Ruffs were foraging, but

also during night time. However, no earthworms were active at the surface during daytime, but the numbers increased after sunset. The average intake rate of Ruffs that were feeding only on earthworms during daytime is strongly related to the density of available earthworms during night time. Additional feeding experiments with six captive male Ruffs were done in spring 2013 to study which sensory cues Ruffs use to find earthworms. In the feeding experiments the Ruffs had to forage individually on a patch with earthworms under three light conditions (day, twilight, night) and with or without white noise (to obscure audio tactile cues) for 15 minutes and the number of earthworms found was scored. The experiments showed that Ruffs are primarily sight feeders and by lacking good night vision, they have difficulties to forage during the night when most prey is available.

5. Learning rates for foraging and parasitizing behaviour in a wasp; overall learning ability or task-specific?

Maartje Liefting
VU-Amsterdam

An organism encounters many situations during its life that may benefit from learned behaviour, like foraging for food, finding mates and re-visiting parasitized patches. Learning is considered a form of behavioural plasticity through which an organism can adjust its behaviour to changes in the environment. How quickly a cue is learned is highly context-dependent, depending on reliability of cues, value of the reward, expected lifespan of the organism etc., and we indeed observe many species-specific learning rates. Even closely related species can demonstrate quite different learning rates and differences in consolidation rates of memory for similar experiences, like associating a neutral cue with finding food or a mate. The question remains however if evolution acts on generalized learning processes, or whether performance in different types of learning tasks evolve more or less independently. We explored this concept in the parasitic wasp *Nasonia vitripennis* by creating an artificial selection line favouring a high learning rate for associating a colour with finding a host. These parasitic wasps both feed from a host and lay eggs on it, so the searching behaviour is focused on both foraging and propagation. We then explored whether the established 'high-learning' lines also exhibit a correlated higher learning rate for a novelty stimulus like odour. Also, changes in a selection of life history traits like fecundity and developmental rate were considered, as well as genetic differences. Here I will present the first results of this study.

6. Parasitoid foraging in multi-herbivore communities – does non-host feeding guild matter?

Marjolein de Rijk, Daowei Yang, Marcel Dicke, Erik Poelman
Wageningen University

Parasitic wasps, or parasitoids, are dependent on hosts for the development of their offspring. Parasitoid eggs are laid in or on the host and the emerged parasitoid larvae use the host as their food source. To find the host, female parasitoids use information from the environment. First, to find the plant the herbivore host is feeding from, the parasitoid utilizes plant volatiles emitted by the plant in response to herbivore feeding. Second, after finding the right plant, the parasitoid uses host kairomones (e.g. frass, secretions) to locate the host on that plant. A natural or agricultural environment normally consists of more than one plant individual or species and more than one herbivore species. The parasitoid therefore is faced with a diverse environment and consequently with a high information input both on plant volatile as on herbivore kairomone level. Part of this information is produced by the presence of herbivores that are not suitable as a host. These so-called non-host herbivores can alter plant volatiles and can produce distracting kairomones. Herbivores with different feeding habits, like phloem feeders and leaf chewers, are known to induce the production of different plant volatile blends and produce different kairomones. This study therefore aimed to elucidate the influence feeding guild of non-hosts has on the foraging behaviour of a parasitoid. We used three experimental set-ups to study parasitoid flight response towards the plant, parasitoid behaviour on the plant and the total parasitization efficiency of the parasitoid.

Session 4

4a: Responsible Science

Conveners: Jim van Belzen (Royal Netherlands Institute for Sea Research)
Marlies Vollebregt (Wageningen University)

1. The role of tree-rings in fighting invasive *Anoplophora* outbreaks

Paul Copini, Ute Sass-Klaassen, Jan den Ouden, Frits Mohren, Antoon Loomans
Wageningen University

The Citrus longhorned beetle, *Anoplophora chinensis* (Forster) and Asian longhorned beetle, *Anoplophora glabripennis* (Motschulsky) (Coleoptera: Cerambycidae) are two of the most destructive and invasive xylobiont insects found worldwide. Both species naturally occur in Asia and are accidentally introduced to the USA, Canada and Europe through wooden packaging materials (*A. glabripennis*) or import of ornamental trees (*A. chinensis*). They may cause serious damage to many angiosperm host species, especially maple trees. Severe measures are taken to eradicate this insect by removal, inspection and destruction of all host species around the infestation site. When exit holes are found in imported trees, it is of crucial importance to know when and where adult longhorn beetles have emerged: the country of origin, the location of import, the nursery or in a private garden. We studied the precision of dating exit holes using tree ring analyses and were able to reconstruct the exact year and season when Anoplophora beetles emerged. Thereby we were able to substantiate tailor-made eradication measures and allocate proper surveillance plans. In addition, we reconstructed the population dynamics of *Anoplophora* sp. in the Netherlands and, inter alia, showed that *Anoplophora* beetles are able to survive and reproduce in the Netherlands.

2. Large-scale spatial dynamics of mussel bed coverage in the German and Dutch Wadden Sea

Eelke Folmer, Jan Drent, Karin Troost, Heike Buettger, Norbert Dankers, Jeroen Jansen, Marnix van Stralen, Gerald Millat, Marc Herlyn, Catharina Philippart
Royal Netherlands Institute for Sea Research

Intertidal mussel beds are important for the functioning and community composition of coastal ecosystems. Modeling spatial dynamics of mussel beds is complicated because suitable habitat is spatially heterogeneously distributed and mussel recruitment is hard to predict. To get insight into the main determinants of dispersion and growth of littoral mussel beds, we analyze spatial distributions and growth patterns in the German and Dutch Wadden Sea. We consider yearly distributions from 36 connected tidal basins between 1999 and 2010 and we use mussel bed distributions for the period 1968 – 1976. We find that in both periods the highest coverage of tidal flats by mussel beds occur in the sheltered basins in the southern Wadden Sea. In contrast to expectation, we do not find evidence that cold winters consistently induced events of synchronous population growth between 1999 and 2010. However, we do find synchronic growth within groups of proximate tidal basins but that synchrony between distant groups is mainly low or negative. We discuss possible mechanisms that may underlie the diverging dynamics. Because the boundaries between synchronic groups are located near river mouths and in areas lacking suitable mussel bed habitat we suggest that the metapopulation is under control of larval dispersal conditions. Our study demonstrates the importance of moving from simple habitat suitability models to models that incorporate metapopulation processes to understand spatial dynamics of mussel beds. The spatio-dynamic structure revealed by this research will be instrumental for that purpose.

3. Accounting for soil ecosystem services in agriculture: the optimal policy response

Lia Hemerik
Wageningen University

Currently, soil ecosystem services in the EU are not being managed in a sustainable way. We have developed a simple static bio-economic model of the impact of farming on soil ecosystem services. For this we need the relationship between nitrogen input (=fertilizer) and expected yield per hectare as well as the valuation of relevant ecosystem services, such as nitrogen retention, carbon sequestration and soil biodiversity. Within the FP7 project SOILSERVICE we have data from four European countries (Czech Republic, Greece, England and Sweden) with which we can parameterize the model. For these parameterizations we numerically search for the optimal policies that will emerge from the simple model. The resulting policies for the different regions are expected to be used to inform policy makers. Moreover, the model can be used as a tool for investigation of the cost-effectiveness of alternative measures for improving flows of soil ecosystem services. In addition, the model can be used to predict for a certain applied policy the amounts of carbon and nitrogen retained per hectare in a particular region.

4. Interacting ecosystem engineers: negative synergistic effects of organic matter loads and lugworm bioirrigation on seagrass

Laura L. Govers, Timon Pieck, Tjeerd J. Bouma, Wouter Suykerbuyk, Alfons J.P. Smolders, Marieke M. van Katwijk
Radboud University Nijmegen

When two ecosystem engineers share the same natural environment, the outcome of their interaction is unclear if they display contrasting habitat modifying effects (e.g. sediment stabilization and sediment destabilization). The outcome of the interaction may depend on local environmental settings such as season or sediment type, which may affect the extent and type of habitat modification by the involved ecosystem engineers. We mechanistically studied the interaction between the sediment stabilizing seagrass *Zostera noltii* and the bioturbating and sediment-destabilizing lugworm *Arenicola marina*, which sometimes successfully co-occur. We investigated 1) if the negative sediment destabilization effect by *Arenicola marina* on *Zostera noltii* might be counteracted by positive biogeochemical effects of bioirrigation by *Arenicola marina* in sulfide-rich sediments and 2) if previously observed nutrient release by *Arenicola marina* bioirrigation would affect seagrasses. Therefore, we tested the separate and combined effects of *Arenicola marina* presence and high porewater sulfide concentrations (induced by organic matter addition) on seagrass biomass in a full-factorial lab experiment. Contrasting to our expectations, we did not find an effect of *Arenicola marina* on porewater sulfide concentrations. *Arenicola marina* activities affected the seagrass physically, and by pumping nutrients, mainly NH_4 and PO_4, from the porewater to the surface water, which promoted epiphyte growth on seagrass leaves in our experimental set-up. To conclude, *Arenicola marina* bioirrigation did not alleviate sulfide stress for seagrasses. Instead, we found synergistic negative effects of *Arenicola marina* presence and high sediment sulfide levels on seagrass biomass.

5. Life histories of an invasive and native ladybird under field conditions, do they interact?

Lidwien Raak
Wageningen University

The Multicoloured Asian ladybird *Harmonia axyridis* (Pallas) (Coleoptera: Coccinellidae) has been introduced in the USA and Europe as a biological control agent of aphids. Soon after its establishment negative effects on non-target organisms were reported, and it is now regarded as an invasive species. Many characteristics of *H. axyridis* are thought to contribute to its invasion success, though most of these have been determined under laboratory conditions. Immature development time and survival of *H. axyridis* as well as of the native species *Adalia bipunctata* L. (Coleoptera: Coccinellidae) were measured in the field during summer in the Netherlands. Larvae were placed on lime trees in groups of either one or both species with ample food to determine if interspecific mortality occurred. Despite incomplete life tables, not unusual for field studies, development time and survival could be estimated for both species. Development time of both species is in line with data from laboratory tests under controlled conditions, and immature survival can reach high levels (i.e. 44.4-100% for *H. axyridis*, and 11.1-76.9% for *A. bipunctata*). When sufficient prey is available, *A. bipunctata* and *H. axyridis* do not interact and intraguild predation does not seem to play a role. *Harmonia axyridis* has a higher survival and, therefore, a faster population growth than *A. bipunctata*, which is one of the factors that may explain the invasive success of *H. axyridis*.

6. Mind the gap: managing cross-ecosystem fluxes in the tropical coastal seascape

Lucy Gwen Gillis, Clive G. Jones, Daphne van der Wal, Allen D. Ziegler, Tjeerd B. Bouma
Royal Netherlands Institute for Sea Research

Ecosystem engineers within an ecosystem can have spatially extended, positive influence on adjacent ecosystems, and these kinds of interactions can be reciprocally reinforcing. These interactions originate from donor ecosystems and can be reduction of wave height, sediment and nutrient concentrations, and are important for the establishment and persistence of recipient ecosystems. Hence, positive interactions at the landscape scale should be included in successful management and monitoring, as well as the creation of ecosystems for coastal defence purposes. If the ecosystem engineers are so degraded (and therefore cannot be expected to alter physical fluxes), the restoration of specific ecosystem engineers that rapidly change specific physical/chemical fluxes may offer a viable option to have ecosystem recovery at larger scales. We propose that positive interactions require a management program, that includes accessing the strength of the flux from the donor to the recipient ecosystems. In addition the physical parameters of the donor and recipient ecosystems engineers need to be monitoring, to detect in what situation they can control the flux. We specifically indicate fast growing species that could quickly fulfil physical functions for other habitats. This paper presents a conceptualised outline of parameters, that should be monitored and recommendations for restoration of species, thereby presenting a promising opportunity to use the physical aspect in ecosystem engineers for in a highly connected seascape. Monitoring of particular parameters and restoration of specific ecosystem engineers in the tropical coastal seascape offers a viable form of integrated coastal management and the future creation of ecosystems for coastal defence.

4b: Migration and stopover ecology

Conveners: Adriaan Dokter (Netherlands Institute of Ecology / University of Amsterdam)
Raymond Klaassen (Dutch Montagu's Harrier Foundation / Netherlands Institute of Ecology)

1. Introduction: New advances in migration and stopover ecology due to novel tracking techniques

Raymond Klaassen
Dutch Montagu's Harrier Foundation / Netherlands Institute of Ecology

Recent developments in tracking technologies allows tracking smaller migrants (using geolocators or small satellite transmitters) and tracking larger migrants in much greater detail (using advanced GPS-loggers). It has been suggested that these novel tracking techniques imply a revolution for the field of migration and stopover ecology. In this introduction lecture I will try to provide an overview of this diverse research field, in which I aim to answer the question whether novel tracking tools really brought progress to the field or that we are just re-inventing the wheel. In my talk I will discuss topics like migration strategies, migratory connectivity and consistency in timing and routes. Finally I will identify some key knowledge gaps, which possibly could be bridged using new techniques.

2. Tracking red knots to explain differences in gut size and diet choice

Thomas Oudman, Allert Bijleveld, Anne Dekinga, John Cluderay, Marwa Kavelaars, Theunis Piersma, Jan van Gils
Royal Netherlands Institute for Sea Research

Animals within a population can differ in their appearance and behaviour. They may be born different, but might also develop differently because they interact with a different local environment. Migrating populations switch environments periodically, and show us how behaviour and appearance can change drastically over time, along with changing demands. If individuals are so flexible, why not do all individuals at the same time and place change to the same state, which suites the demands best? We present an example in migrating shorebirds, red knots. Red knots can triple the mass of their intestines, depending on the demand. Average gut sizes vary greatly between seasons, but also between individuals at the same time and location. Possibly, these differences result from a large heterogeneity in the distribution of food. We use data from radio tagged red knots to infer whether individual foraging paths lead to different food availability and thus a change in required gut size. We manipulated gut sizes before release, providing insight in the causal relationship between gut size and foraging path.

3. Brent Geese fuelling for migration: leisure or overwork?

Adriaan M. Dokter, Wimke Fokkema, Bart S. Ebbinge, Bart A. Nolet, Han Olff, Henk P. van der Jeugd
Netherlands Institute of Ecology

In terms of long-distance migration, Brent Geese are the sprinters among geese. The 4500 km journey between the staging site in the Wadden Sea and Taimyr Peninsula in arctic Russia is covered only in a period of two weeks or less. Spring staging and breeding areas are thus closely connected in time, therefore the conditions in the Wadden Sea will quickly carry over to the breeding site. It has been shown that birds in good condition at the end of spring staging are more likely to return with offspring, which emphasizes the importance of the spring staging period. In this study we ask ourselves to what extent foraging conditions and food availability form a bottleneck for the successful fattening up of the geese, and how individual differences in condition arise at the spring stopover. In spring 2012, we equipped 30 Brent staging in agricultural and saltmarsh habitats with novel high duty cycle GPS and accelerometer loggers. These loggers measured the foraging time budgets and activity of individual geese in great detail, allowing us to quantify when in the seasonal cycle the geese foraged intensively and when not. These data was complemented with detailed observational studies on intake rates and a monitoring program of plant quality, from which we derived energy budgets for individual birds. Our data reveal that only in the final two weeks before departure the geese make full use of the total available time for foraging. We will discuss to what extent food quality, food availability as well as conspecific competition can be limiting factors for the accumulation of body reserves. Our results suggest that the bird's internal physiological state may be very important in explaining individual differences in condition at the end of spring staging.

4. Peeking spring from afar? More accurate timing of migration at higher predictability of phenology along migration routes

Andrea Kölzsch, Silke Bauer, Rob de Boer, Larry Griffin, David Cabot, Klaus-Michael Exo, Henk van der Jeugd, Bart A. Nolet
Netherlands Institute of Ecology / Max Planck Institute for Ornithology

Herbivorous birds are hypothesized to migrate in spring along a seasonal gradient of plant profitability towards their breeding grounds (*green wave hypothesis*). We used a comparative approach to examine whether flyways differed in the predictability of spring conditions at stopovers along the route, and whether this was reflected in the degree to which birds were following the green wave. Barnacle geese (*Branta leucopsis*) were successfully tracked with solar Argos/GPS PTTs from their wintering grounds to their breeding sites in Greenland, Svalbard and the Barents Sea. All birds stopped several times during migration and stopover site could be combined into a set of 16 general stopover regions. The predictability of climatic conditions along the flyways differed, mainly because of the presence or absence of ecological barriers, and goose arrival at stopovers as well as the breeding grounds was closer to the local onset of spring when this predictability was higher. Whether a bird would breed that year was related to timely stopover use during migration only in geese following the flyway with the highest predictability. Our results suggest that a chain of correlations between climatic conditions at subsequent stopovers is enabling geese to closely track the green wave, and that the birds' precision of migratory timing is lower when such correlations are disrupted by climatic barriers. Asynchronous climate warming along their migration route may hamper accurate timing of these long-distance migrations in the future.

5. Opportunistic tracking of food resources in the northern Sahel: plasticity in migratory behaviour of a Palaearctic-African bird species

Rien van Wijk
Swiss Ornithological Institute

Temporal and spatial components of migratory behaviour are often considered to be rather fixed traits: migratory behaviour of both individuals and populations have been shown to vary only slightly from year to year. In this study, however, we show that Eurasian Hoopoes (*Upupa epops epops*) are very plastic in their migratory behaviour. We tracked Hoopoes from a breeding population in Wallis, Switzerland, using geolocators between 2009 and 2012. They spent the nonbreeding season in Sahelian West Africa. Individuals did change nonbreeding sites from year to year (roughly 50% of individuals tracked at least 2 years). On a population level most birds spent the nonbreeding season south of 15°N in the Sahel till the Sahel-Sudanian climatic zone (average latitude 2009 11.5, 2010 13.5, 2011 17.5 and 2012 17). Especially in 2012, however, many birds were found more northwards than in the previous years (up till 23°N). Importantly, this was a rather dry year with generally intermediate rainfall in the Sahel. Hoopoes seem to have opportunistically profited from an outbreak of Desert Locusts (*Schistocerca gregaria*). Occurrence of these unpredictable outbreaks do not solely depend on increased rainfall in a given year. In summary, our results show that migratory birds are probably far more plastic in their spatial migratory behaviour as believed so far, enabling them to opportunistically benefit from unpredictable, but abundant food resources. Temporal and spatial components of migratory behaviour are often considered to be rather fixed traits: migratory behaviour of both individuals and populations have been shown to vary only slightly from year to year. In this study, however, we show that Eurasian Hoopoes (*Upupa epops epops*) are very plastic in their migratory behaviour.

6. How migrating Honey Buzzards modulate fine-scale flight behaviour as a function of weather conditions encountered *en route*

Wouter M.G. Vansteelant, Judy Shamoun-Baranes, Jan van Diermen, Emiel van Loon, Willem Bouten
University of Amsterdam

During migration, birds contend with varying weather conditions to arrive timely at their seasonal destinations. Soaring birds are particularly sensitive to weather conditions because they use weather to power their flights, and are at the mercy of prevailing winds for about half the time they spend on the wing. Yet little is known about how soaring migrants modulate their soaring-gliding flight at the fine scale in relation to weather conditions they encounter *en route*. We will show preliminary results of an ongoing study into the influence of wind conditions and thermal convection on fine-scale flight behaviour of an obligate soaring migrant. We equipped five European Honey Buzzards *Pernis apivorus* with GPS loggers which were programmed to record locations at 10-sec intervals half an hour, twice in autumn 2012 and spring 2013. We expect honey buzzards to adjust their air speeds during gliding to maximize cross country speeds while accounting for experienced wind conditions and thermal convection. To test this hypothesis we use flight mechanical theory to predict optimal gliding air speeds of a Honey Buzzard of average size and weight in function of soaring climbing rates. We subsequently test whether Honey Buzzards travel slower or faster than optimal speeds depending on environmental conditions (e.g. due to restricted flight altitudes in windy conditions or over complex terrain) and their wind compensation strategies. Finally, we describe regional and seasonal patterns in soaring and gliding behaviour and explain how these patterns arise due to weather conditions and environmental or behavioural mechanisms.

4c: P dynamics in terrestrial and aquatic ecosystems

Conveners: Martin Wassen (Utrecht University)
Peter van Bodegom (VU-Amsterdam)
Yuki Fujita (KWR Watercycle Research Institute)
Harry Olde Venterink (Vrije Universiteit Brussel)

1. P dynamics in terrestrial and aquatic ecosystems

Martin J. Wassen, Peter M. van Bodegom, Yuki Fujita, Harry Olde Venterink
Utrecht University

Most ecosystems are co-limited by N and P. However, there is considerable variation in the type of nutrient limitation across aquatic and terrestrial ecosystems. N:P stoichiometry is closely related to productivity, species diversity and species traits. The benefits of certain traits for P acquisition, P-use efficiency and P-conservation for survival and competition strength in P-limited conditions is clear. However, we should know more about the global distribution of N and P limitation; how this is impacted by global change drivers such as N deposition and climate change and how species may respond to such changes depending on their traits and the response of their competitors.

2. A phosphorus limit for biodiversity in European grasslands?

Tobias Ceulemans
KU-Leuven

Nutrient enrichment has been identified as a serious threat to biodiversity worldwide. In terrestrial ecosystems, the deleterious effects of nitrogen (N) pollution are increasingly understood and mitigating environmental policies have been developed. Compared to N however, the effects of increased phosphorus (P) on biodiversity have received far less attention. Here, the major objective is to explore the relative importance of N and P for plant species richness using a dataset covering 479 grasslands throughout Europe. The results show that plant species richness is consistently negatively related to soil P up to a clear threshold above which biodiversity remains at a constant low level. Furthermore, this relationship appeared independent from the level of atmospheric N deposition and soil acidity. As soil P is known to be extremely persistent in the soil, these results suggest that agro-environmental schemes should include grasslands that are permanently free from P fertilization.

3. P limitation and excess; subterranean blues and joys

Leon P.M. Lamers
Radboud University Nijmegen

Next to carbon (C) and nitrogen (N) availability, phosphorus (P) supply needs to be sufficient for optimal growth of organisms including plants. Unlike that of C and N, the global and regional biogeochemical cycling of P hardly includes an atmospheric compound. This means that edaphic conditions and rhizospheric processes strongly rule P availability, and dictate the responses of individual plants, plant communities and plant-microorganism communities to different P loads. In addition, responses to the loads of other essential nutrients such as N are significantly affected by P availability. In my talk, I will try to drag your head into the soil and focus on the subterranean evolutionary outcomes with respect to P limitation and P excess, and their implications for plant-microorganism communities.

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

Christian Fritz, Eric Visser, Theo Elzenga, Leon Lamers, Veronica Pancotto, Gijs van Dijk, Eva van den Elzen, Fons Smolders
Radboud University Nijmegen

Sphagnum-bog ecosystems have a limited capability to retain carbon and nutrients when subjected to increased nitrogen (N) deposition. Balancing the N:P stoichiometry by P-addition may dilute negative effects of nitrogen by increasing biomass production of *Sphagnum* mosses. However, it is unclear how additional phosphorus changes growth conditions in bogs and whether P-addition can alleviate physiological N-stress. We combine results from a 3-year fertilisation experiment in a pristine *Sphagnum magellanicum* bog (Patagonia) with uptake kinetics from ecophysiological experiments applying nitrate, ammonium and phosphate, respectively. Low background nitrogen deposition at the pristine field site (<0.2 g N m^{-2} y^{-1}) rendered a broad N:P stoichiometry varying from 4 to 30 adding phosphorus (1 g P m^{-2} y^{-1}) and nitrogen (4 g N m^{-2} y^{-1}). A saturation model of nutrient uptake was fitted using a range (1-500 µM) of nitrogen and phosphorus applied in the laboratory. P-addition improved *Sphagnum* growth with highest production at an intermediate N:P stoichiometry (12 g g^{-1}) and highest foliar nutrient contents. In contrast, P-addition enhanced the desiccation of *Sphagnum* through lowering the water retention of the moss carpet. Uptake kinetics suggested that *Sphagnum*-mosses adjust nutrient uptake rates improving ultimately tissue N:P stoichiometry. These results are compared with P-acquisition under desiccation by *Zea mays*. We

conclude that *Sphagnum*-bog ecosystems lose their ability to adjust nutrient acquisition at a highly imbalanced N:P stoichiometry. P-addition alone may fail to compensate for N-deposition due to increase susceptibility to desiccation and limited alleviation of physiological stress caused by N in excess.

5. An offshore gradient from phosphorus to nitrogen limitation in the North Sea: A challenge to traditional thought

Amanda Burson, Maayke Stomp, Jef Huisman
Dutch Montagu's Harrier Foundation / University of Groningen

Regulatory measures to reduce eutrophication of Dutch coastal waters have resulted in a much more effective decline of phosphorus when compared to nitrogen concentrations in coastal riverine outflow. This has caused an increase in the ratio of nitrogen to phosphorus in the coastal areas most influenced by freshwater nutrient inputs. We investigated the induced changes in nitrogen and phosphorus limitation of phytoplankton growth in the North Sea which, like most seas, has been traditionally thought of as N-limited. A total of 4 research cruises, spanning the phytoplankton growth period, were conducted along a 450 km transect going from nearshore to the central North Sea. Dissolved inorganic nutrients revealed extreme N:P ratios of 375:1 nearshore during the spring bloom, which is well above the typical Redfield ratio of 16:1 and a strong indicator of P-limitation. In contrast, the outermost station had a N:P ratio of 1:1, indicating N-limitation. Hence, we hypothesized that the North Sea does not experience one universal nutrient limitation, but instead is exposed to an offshore gradient from P to N limitation. To test this hypothesis, nutrient bioassay experiments were performed on-board using water samples from a series of stations along the offshore transect. The links between ambient N:P, particulate N:P and growth responses in these bioassays indeed revealed a gradient from P to N limitation; where P-limitation is most prevalent nearshore, co-limitation of N and P occurs in a transition zone beyond fluvial dominated nutrient inputs, and finally the traditional N- limitation occurs in waters most influenced by the nitrogen depleted Atlantic Ocean waters. Resource competition theory predicts that such shifts in limiting resources are likely to lead to changes in phytoplankton community composition, diversity and productivity in the North Sea. To further unravel the impact of changes in the N:P input in the North Sea, observed shifts in phytoplankton community along the offshore N:P gradient were analysed. This research thus elucidates that phosphorus reduction measures have had a major impact on the coastal North Sea, specifically with respect to P- limitation of phytoplankton growth and composition.

6. Nitrogen *versus* phosphorus enrichment effects on plant species richness in herbaceous ecosystems

Roland Bobbink, Merel B. Soons, Mariet M. Hefting, Edu Dorland, Leon P. M. Lamers
Radboud University Nijmegen

Both nitrogen (N) and phosphorus (P) from anthropogenic sources continue to enrich the biosphere, but their relative contributions in causing vegetation changes and plant species losses have scarcely been quantified. Here, we compare the effects of N *versus* P enrichment on species richness of natural and semi-natural herbaceous ecosystems across the world, using a meta-analysis of 70 longer-term nutrient addition experiments in the field. Our experiment-based approach shows that accumulating N additions significantly reduce plant species richness in terrestrial and wetland ecosystems on the longer term, whereas accumulating P additions hardly affect species numbers in the published studies. In addition, negative effects on species richness are greatest in the most species-rich vegetation types. Our finding that the effect of P input is consistently smaller than that of N in the studied ecosystems sheds new light on the ongoing debate of the relative importance of N and P enrichment. It unequivocally demonstrates the urgency for strategies to control or prevent he increase of atmospheric N loading of (semi-)natural areas in pristine, low N situations.

4d: Tropical ecology

Conveners: Lourens Poorter (Wageningen University)
Hans ter Steege (Naturalis Biodiversity Center)
Joost Duivenvoorden (University of Amsterdam)

1. The Amazon. Understanding the world's most diverse forest

Hans ter Steege
Naturalis Biodiversity Centre

Recent decades have seen a major international effort to inventory tree communities in the Amazon Basin and Guiana Shield (Amazonia), but the vast extent and record diversity of these forests have hampered an understanding of basin-wide patterns. To overcome this obstacle we compiled and standardized species-level data on more than half a million trees in 1170 plots sampling all major lowland forest types to explore patterns of commonness, rarity, and richness. The ~6 million km2 Amazonian lowlands were divided into 1-degree cells and mean tree density was estimated for each cell using a loess regression model that included no environmental data but was based exclusively on the geographic location of tree plots. A similar model, allied with a bootstrapping exercise to quantify sampling error, was used to generate estimated Amazon-wide abundances of the 4962 valid species in the dataset. We estimated the total number of tree species in the Amazon by fitting the mean rank-abundance data to Fisher's log-series distribution. Our analyses suggest that lowland Amazonia harbors 3.9 x 1011 trees and ~16,000 tree species. We found 227 'hyper-dominant' species (1.4% of the total) to be so common that together they account for half of all trees in Amazonia, while the rarest 11,000 species account for just 0.12% of trees. Most hyper-dominants are habitat specialists that have large geographic ranges but are only dominant in 1 or 2 regions of the basin, and a median 41% of trees in individual plots belong to hyper-dominants. A disproportionate number of hyper-dominants are palms, Myristicaceae, and Lecythidaceae. An appreciation of how thoroughly common species dominate the basin has the potential to simplify research in Amazonian biogeochemistry, ecology, and vegetation mapping. Such advances are urgently needed in light of the >10,000 rare, poorly known, and potentially threatened tree species in the Amazon.

2. Mycota of understudied biodiversity hotspots – deep DNA sequencing reveals hyperdiverse communities and strong habitat partitioning along altitudinal gradients in cloud forest communities in Borneo and in the Andes

József Geml, Nicolás Pastor, Luis N. Morgado, Tatiana A. Semenova, Eduardo R. Nouhra
Naturalis Biodiversity Center

Cloud forests are not only among the world's most biologically important ecosystems with their tremendous biodiversity and high rate of endemism, but they also provide crucial water supplies to human settlements and agricultural areas. Mount Kinabalu in Borneo and the Yungas forest on the eastern slopes of the Andes have been known to be particularly rich in plant and animal species and both have been designated as UNESCO Biosphere Reserves. Based on proportional diversity estimates around the globe, the fungi are at least as diverse (probably even more). Yet, virtually nothing is known about the true diversity and distribution patterns of fungi in these regions. We carried out Ion Torrent sequencing of soil samples taken along multiple altitudinal gradients in the Yungas in Argentina and on Mount Kinabalu and in the Crocker Range in Malaysian Borneo. The samples represent all major altitudinal forest types from ca. 500 to 2500 m in the Yungas and from 300 to 4000 m in Borneo. Our results suggests that the sampled communities are very diverse, harbouring numerous undescribed and/or previously unsequenced taxa. NMDS analyses suggested that fungal community composition correlated strongly with forest type, with many OTUs showing strong preference for a certain elevation zone. Several ecological groups showed similar distributional trends in the two regions, e.g., saprobic fungi were more diverse at lower elevations, while root endophytes were more dominant at higher altitudes. Our data offer an unprecedented insight into the diversity and spatial distribution of fungi in tropical and subtropical cloud forests.

3. Geological change as driver of plant biogeography in Amazonia

Carina Hoorn
University of Amsterdam

The Amazon region harbours a wealth of biodiversity, which was formed by the interaction of macro-scale and micro-scale processes during the Cenozoic era (<65 million years ago (Ma)). Here I will focus on the sedimentary history of western Amazonia (23 Ma). During this period the area came under the spell of the uplifting Andes, a process that caused a plethora of changes in climate, sedimentary environments, bedrock, soil etc. In particular the changes in discharge, sediment composition and depositional environment might have influenced, and changed, the composition of palm taxa. The pollen record in western Amazonia shows that *Mauritia*-type palms were very common during the early Miocene (23-16 Ma), but that after 16 Ma, coinciding with a change in sediment composition and environment, a new pollen type, that shares some notable characteristics with the pollen of the present species of Mauritiinae, emerged and took over the previous niche of

Mauritia in the pollen spectra. This new taxon, *Grimsdalea,* was very abundant during the Middle Miocene only to disappear again towards the end of the Pliocene. Its extinction was, most likely, induced by global cooling during the Quaternary and/or aridification. *Grimsdalea* is not the only taxon that seems to have been influenced by the geological changes in the region. It is hoped that further study of pollen morphology, numerical analysis of pollen data and molecular phylogenies will elucidate further the evolutionary history of vegetation in the Amazon region.

4. No evidence for CO2 fertilization of tropical forests over the last century

Peter van der Sleen, Peter Groenendijk, Mart Vlam, Niels P.R. Anten, Arnoud Boom, Frans Bongers, Thijs L. Pons, Gideon Terburg, Pieter A. Zuidema
Wageningen University / Instituto Boliviano de Investigación Forestal (IBIF)

Studies on small forest plots across the tropics indicate increased biomass and forest dynamics in the last decades. It is commonly believed that the rise of atmospheric CO_2 is fertilizing tropical trees, allowing them to grow faster, but this hypothesis is controversial. In theory, rising CO_2 level increases plant photosynthetic rate and water-use efficiency, but evidence that these physiological responses indeed stimulate tropical tree growth is lacking. We analysed growth rings of 1100 trees from Bolivia, Thailand and Cameroon. To account for ontogenetic changes in growth, we compared growth rates across fixed diameter classes. On the same trees, an estimate of the intercellular CO_2 concentration in the leaves (*Ci*) and of water-use efficiency (*iWUE*) were derived by measuring stable carbon isotopes in the wood of annual growth rings. We found a consisted increase of *Ci* and *iWUE* over the past 150 years in all tree species studied and across the three sites. However, we found that this increased *iWUE* did not translate to a concurrent acceleration of tree growth. Our results imply that other stressors have impeded growth stimulation of tropical trees in response to elevated CO_2 levels. Our findings call for caution in assuming a strong CO_2 fertilization effect on tree growth in coupled vegetation-climate models, as this may inflate estimates of biomass growth of tropical forests under future CO_2 levels and thus their capacity to mitigate future global warming.

5. Do community functional properties predict biomass and productivity of tropical forests?

Marielos Peña-Claros, Lourens Poorter, Bryan Finegan, 12 other members of the DiverSus network
Wageningen University / Instituto Boliviano de Investigación Forestal (IBIF)

Tropical forests are hotspots of biodiversity and store a quarter of the global terrestrial carbon. Experimental studies from temperate grasslands indicate that biodiversity may enhance vegetation productivity because species are complementary in resource use and that, in line with the biomass ratio hypothesis, community-weighted mean (CWM) trait values predict productivity. Yet, it is not clear whether this also applies for highly diverse, natural tropical forest systems. Here we present results from the DiverSus project, considering four tropical forests in Bolivia, Brazil, and Costa Rica. Standing aboveground biomass AGB and biomass increment ΔAGB were related to community mean values (CWM) of eight functional traits, and to indices describing the variation of trait values in the community. We found that CWMs were stronger predictors of AGB and ΔAGB. Tropical forest stands with high maximum tree height, and with "fast", productive leaves that capture a lot of light (high leaf area per unit leaf mass) and have a high photosynthetic capacity (high leaf nitrogen concentration) have high ΔAGB. This fast lifestyle results in low standing biomass stocks. Functional variety was not related to AGB or ΔAGB, while initial ABG was negatively correlated with ΔAGB. These results indicate that CWMs of the studied traits are strong drivers of ecosystem biomass and carbon storage and sequestration in tropical moist and wet forests.

6. Forensic forest ecology: unravelling the stand history of tropical forests

Mart Vlam, Peter Groenendijk, Peter van der Sleen, Patrick J. Baker, Sarayudh Bunyavejchewin, Godefridus M. J. Mohren, Pieter A. Zuidema
Wageningen University

Tropical forests are commonly seen as relatively stable systems that are mainly driven by small scale gap dynamics. However, there is increased evidence that tropical forests are subject to infrequent but severe canopy disturbances, just like temperate forests. Recovery from these disturbances may result in positive trends in forest biomass that have been observed in forest monitoring plots and have been attributed to global change. Here we present a disturbance reconstruction based on tree-ring dating of sites in Bolivia, Cameroon and Thailand and we assessed the evidence for past severe canopy disturbances. In a ~200 ha plot we sampled trees of 4-5 species and used tree-ring counts to date each tree to its respective year of establishment. The age distribution was used to investigate whether age cohorts were present and spatial pattern analysis was used to determine the spatial aggregation of tree age. The tree age distribution showed evidence of regeneration failure of canopy tree species in Cameroon and Thailand and spatial pattern analysis revealed that tree age was significantly aggregated at a hectare level. This suggests that regeneration was historically higher due to large canopy openings, most likely related to wind-fall, drought or fire. This study adds new insights to the growing body of evidence that long term dynamics of tropical forests are heavily

impacted by rare large scale disturbances. Determining whether observed trends in tropical forest biomass and tree growth are actually driven by local stand dynamics or global change is an important question for future research.

Poster titles and numbers

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

#	Name	Poster title
1	Maaike van Agtmaal	Remote beneficials in soil potential role of bacterial volatiles in suppression of soil-borne fungal pathogens
2	Cassandra van Altena	Trophic organization as indicator of ecosystem resilience
3	Yani Bai	Relationship between bacterial chitinase and fungal biomass in potato rhizosphere
4	Lisette Bakker	Predicting drought resilience of grassland plant communities through belowground functional traits
5	Janna Barel	Traits in the Rhizosphere: on microbial composition and plant-soil feedback
6	Jim van Belzen	To tip or not to tip, that is the question
7	Roeland Bom	Acceleration based behavioural classification
8	Luc de Bruyn	Shifts in the life-history traits of the Round Goby (*Neogobius melanostomus*) in its Northwest-European invasive range
9	Onno Calf	Bittersweet sugars as indirect defence strategy
10	Haobing Cao	A study on the range expansion of saltmarshes and its underlying mechanism in the Yangtze Estuary, China
11	Bin Chen	Roots of neighbours modify seed size distribution of kidney bean plants
12	Marlies Coopman	Origin of *Daphnia magna* involved in susceptibility to White Bacterial Disease in presence of *Microcystis aeruginosa*
13	Loreta Cornacchia	Does self-organization promote species coexistence? A study on habitat modification by river vegetation
14	Tisja Daggers	Benthic diatoms as indicators for ecosystem structuring in tidal shallow waters
15	Sigrid Dassen	Plant-soil feedback and diversity-productivity relationships
16	Ellen Decaestecker	Damped long-term host–parasite Red Queen co-evolutionary dynamics: a reflection of dilution effects ?
17	Steven Declerck	Rapid evolution in rotifers under conditions of stoichiometric imbalance

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18	Mathias Dillen	Drought stress, tree diversity and ecosystem functioning? Leaf damage symptoms of oak saplings in a phytometer
19	Gilian van Duijvendijk	Rodent ecology and Lyme disease risk
20	Jessie Engelen	Metropole Flanders: spatial and environmental determinants of eco-evo dynamics in zooplankton communities
21	Nina Fatouros	Synergism between direct and indirect defence controls herbivore eggs on a wild crucifer
22	Thijs Fijen	Animal dung in and around bird nests – a tool to influence microclimate?
23	Rienk Fokkema	The effect of reproductive effort on the acquisition of resources in later life: sleeping places
24	Oscar Franken	A framework to investigate food web responses to extreme climatic events
25	Daan Gerla	The effects of drilling mud and sediment deposition on cold-water coral
26	Joëlle Gérard	Effect of phosphorus reduction on invasive macrophytes' growth, competitiveness and traits
27	Luuk van Gerven	Competition between floating and submerged plants for nutrients and light: an unfair game
28	Amir Faraz Ghasemi	Ecological assessment of the Haraz River based on the benthic macroinvertebrates in the southern Caspian Sea Basin
29	Florien Gorter	Experimental evolution of heavy metal tolerance in changing environments
30	Lynn Govaert	Price equation in evolutionary ecology
31	Christian Guill	Ontogenetic diet shifts increase persistence of large model food webs
32	Martijn Hammers	Does senescence favour cooperative breeding in the Seychelles warbler?
33	Joost van den Heuvel	Linking phenotypic to genetic variation of the least killifish (*Heterandria formosa*) using a candidate gene approach
34	Klaas Natan Hoefnagel	Faster growth, but smaller size in warmer temperatures: mediated by oxygen?
35	Ruth Howison	A rock paper scissors game on the salt marsh
36	Zheng Huang	The effect of connectivity on pathogen transmission in metapopulations linked to host movement and population extinction
37	Annette Janssen	Taihu's (China) pathway to eutrophication
38	Jingying Jing	Complementarity and selection effects of early- and mid-successional plant communities
39	Maaike de Jong	Artificial light at night affecting avian behaviour

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40	Alexandre Jousset	Colony expansion enforces cooperation in *Pseudomonas fluorescens*
41	Alexa Sarina Jung	Spatial, temporal and inter-annual patterns in predation pressure by the epibenthic community at the Balgzand intertidal
42	Theun Karelse	Art and Ecology
43	Xavier Karreman	How does species diversity affect evolutionary responses to environmental change?
44	Rosemarie Kentie	On grassland monocultures Black-tailed Godwits are doomed
45	Joost Keuskamp	Effects of nutrient enrichment on microbial exoenzyme activity in mangrove peat
46	Saskia Klumpers	How rewards can determine foraging behaviour in pollination networks
47	Bram Knegt	Needy plants make fungal friends
48	Xiangzhen Kong	Modelling the large shallow Chinese lake, Lake Chaohu with PClake
49	Lammert Kooistra	Predicting plant communities with remote sensing
50	Martine Kox	N-deposition effects on diazotorophic activity and community composition associated with peat moss
51	Maria de Lamares Pereira	Monitoring the impact of soil management on plant spectral reflectance and soil resistance capacity
52	Thomas Lameris	Arctic Barnies: How can Arctic-nesting Barnacle Geese cope with Arctic amplification?
53	Ivo Laros	Monitoring mite diversity in European soils using high throughput (E)DNA barcoding tools
54	Jenny Lazebnik	Monitoring the effects of cisgenic blight-resistance potatoes on the insect community
55	Paolo di Lonardo	Priming effect of Soil Organic Matter: a question of mining or energy?
56	Marloes van Loon	How competition affects the response of plants to climate change
57	Sascha van der Meer	Variation in floral sex allocation and its effect on reproductive success
58	Alina Miksiunaite	The higher salinity, the more diversity?
59	Ntuthuko Mkhize	Effects of tannins on body weight, faecal nitrogen and nutritionally related blood metabolites of free-ranging goats in Africa
60	Simeon Moons	Benthic bio-geomorphology of the Sand Engine
61	Luis Morgado	Do Arctic ectomycorrhizal fungal communities change with the summer temperature increase?

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62	Lieke Mulder	Intertidal flats: sources or sinks of N and P?
63	Sil Nieuwhof	Shortscale inhibition of endobenthos around epibenthic shellfish
64	Stijn van Onsem	Changes in reproductive fitness and strategy in two submerged macrophyte species in response to high Lemna cover
65	Imma Oliveras	Linking fire regimes, climate and biomass burning emissions at different scales in the tropical Andes
66	Natalie Oram	Root turnover in grassland biodiversity experiments: root traits and interactions with soil biota
67	Hélène de Paoli	Testing for the tough and the rough. Can subtidal mussels be used to restore intertidal mussel beds?
68	Foteini Paschalidou	Plant mediated effects of *Pieris brassicae* egg deposition, on preference of the larval parasitoid *Cotesia glomerata*
69	Hendrik Poorter	Biomass allocation differs among species
70	Estela Quintero Vallejo	The effect of Amazonian dark earth in understory composition in an Amazonian forest in Bolivia
71	Janneke Ravenek	Relations between root traits and competitive success
72	Max-Bernhard Rudnick	Are saprophytic fungi a source of food for rhizosphere bacteria?
73	Suvi Ruuskanen	Short-term adjustment in egg composition to environmental variation
74	Sirgi Saar	Chemical cues produced by plant roots mediate neighbour recognition and trigger complex behavioural changes
75	Lucia Salis	Plasticity in seasonal timing: can the winter moth adjust their phenology to match the annual cycle?
76	Jelmer Samplonius	Prey choice depends on chick age in pied flycatchers
77	Maria Joao Santos	Remote sensing of wildlife-habitat use in space and time: European and American badgers in Mediterranean ecosystems
78	Masha van der Sande	Drivers of biomass growth in tropical canopy trees: credits to sapwood
79	Tatiana Semenova	Ascomycetous fungi respond differently to long-term experimental warming in dry and moist arctic tundra in Alaska
80	Mitra Shariatinajafabadi	MODIS NDVI for tracking Barnacle goose spring migration
81	Koen Siteur	Beyond Turing: patterned ecosystems subject to environmental change
82	Laura Soissons	Another seagrass tale: "The fast and the slow growing"
83	Kamiel Spoelstra	Experimental illumination of natural habitat - an ecosystem-wide study on the effects of artificial light

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84	Willem Stock	The interactions of copepods with benthic bacteria and diatoms promote nitrogen retention in marine sediments
85	Sven Teurlincx	Regional biodiversity and land use in ditch ecosystems
86	Barbara Mizumo Tomotani	Temporal organization of pied flycatchers (*Ficedula hypoleuca*) in the field
87	Ana Vasques	The role of seed provenance in the early development of *Arbutus unedo* seedlings under contrasting watering conditions
88	Floris Vanderhaeghe	Spatial allocation of Natura 2000 conservation targets using ecological and socio-economical optimization modelling
89	Pieter van Veelen	Do environmental microbes affect maternal egg defense in birds
90	Mandy Velthuis	Carbon retention by phytoplankton and macrophytes in freshwater lakes
91	Tess van de Voorde	Biochar application to natural grasslands stimulates arbuscular mycorrhizal fungi
92	Michiel Verhofstad	MacroManagement of nuisance macrophyte species
93	Annemieke van der Wal	LOGLIFE at the microscale: the fungal factor in variation of wood decay rates
94	Abraham Wate	Global Ecovillage Network
95	Monique Weemstra	Tree root traits and mycorrhizal abundance on contrasting soils
96	Rutger Wilschut	Belowground tri-trophic interactions of range expanding plant species
97	Iris de Winter	Parasite prevalence in lemurs
98	Jelle Zandveld	Nutrient-dependent ageing and reproduction in Drosophila
99	Yong Zhang	Elevation mediates coexistence of geese species in wetlands
100	Qian Zhang	Bittersweet in response to flooding-developmental stage matters
101	Zhenchang Zhu	Gardening by marine worms can improve pioneer seedling establishment in salt marshes
102	Yuan Zhuang	Thermal properties of leaf traits
103	Juan Zuo	Macro-detritivore diversity associated with wood decomposition