NAEM 2022

Netherlands Annual Ecology Meeting

20 & 21 September 2022

Congrescentrum De Werelt, Lunteren

- ***Programme***
- ***Presentation abstracts***
- ***Poster titles and numbers***
- ***Participants list***
- ***Practical information***

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Programme

Tuesday 11 February

08:30	**Main Entrance**				
	Registration				
	Air / Fire				
	Setting up posters / Coffee and tea				
10:15	**Word of Welcome (Earth) –** Hans de Kroon (chair NERN) and Dedmer van der Waal (chair organising committee NAEM)				
	Plenary 1: "Animal migration" Animal migration is a spectacular natural phenomenon, resulting in the redistribution of entire populations and billions of organisms. This session addresses some of the adaptations and challenges facing animal migrations when traversing hundreds to thousands of kilometers over land or in the air, and shows how different techniques can be used to inform us about how, when, where and why animals move.				
10:30	**Integrating animal movement with the conservation and management of ecosystems: behavioural and physiological insights from the Serengeti wildebeest migration** (**Grant Hopcraft**, Institute of Biodiversity, Animal Health & Comparative Medicine, University of Glasgow, UK)				
11.15	**Migration through the troposphere** (**Judy Shamoun-Baranes**, Institute for Biodiversity and Ecosystem Dynamics, University of Amsterdam)				
12:00	**Lunch (Restaurant)**				
	Earth	**Water**	**Room 21**	**Rooms 2 & 3**	**Rooms 10 & 11**
13:30	**Parallel 1a:** **Animal migrations: pressures and adaptation to global change**	**Parallel 1b:** **Ecology of the microbiome**	**Parallel 1c:** **Biogeography and macroecology in the Anthropocene and Quaternary, part 1**	**Parallel 1d:** **Bending the biodiversity curve**	**Parallel 1e:** **Invasive alien species, tolerate or extirpate?**
	Conveners: 1. Thomas Lameris (Royal Netherlands Institute for Sea Research) 2. Frank van Langevelde (Wageningen University & Research) 3. Fleur Visser (University of Amsterdam)	*Conveners*: 1. Marjolein Bruijning (Princeton University) 2. Shumaila Rasool (Netherlands Institute of Ecology) 3. Dharani Kamalachandran (Utrecht University)	*Conveners*: 1. Sietze Norder (Utrecht University) 2. Kenneth Rijsdijk (University of Amsterdam) 3. Majoi de Novaes Nascimento (University of Amsterdam)	*Conveners:* 1. Nicky Faber (Wageningen University & Research) 2. Bart Pannebakker (Wageningen University & Research) 3. Chris Smit (University of Groningen)	*Conveners*: 1. Annemarieke Spitzen (RAVON) 2. Baudewijn Ode (FLORON)

	Many animals are adapted to a life on the move, and thereby form a fundamental part of multiple ecosystems along their migration routes. Due to increasing human pressures such as anthropogenic barriers and stressors in migration corridors, over-harvesting and climate warming, migratory animals are facing increasing risks during their migrations, causing migratory populations to decline or to switch to a residential lifestyle. In this session we welcome all talks discussing animal migration in the light of environmental change.	The microbiome provides benefits to hosts, shaping immune development, metabolism and pathogen resistance. Complex patterns of transmission between hosts, and microbial interactions within hosts make understanding and predicting microbiome dynamics challenging. This session aims to foster an increased understanding, and centers on both fundamental and applied developments in the field. How does the microbiome contribute to host adaptation, and can we harness the potential of the microbiome for the protection of crop species or improvement of human health?	Biodiversity is unequally distributed across the globe. Biogeographers and macroecologists try to understand the underlying sources of this variation. The aim of this session is to explore the contribution of climate, geography, and human activities shaping the spatial and temporal variation in biodiversity.	The urgency to halt biodiversity decline has spurred the development of unconventional wildlife management methods. Examples include restricting predator species like wolves or domestic cats, or introducing genetically modified organisms for population control, such as in gene drives. Perceived controversies include ecological risks, animal welfare issues, and ideas about the ideal state of nature. In this session, we will highlight unconventional management methods to facilitate debate on what we should do to conserve biodiversity.	Invasive alien species (IAS), ranging from pathogens, plants, insects to mammals are frequently introduced in natural systems. Upon detection, the impact of IAS needs to be assessed as well as the feasibility and costs of eradication or containment. Horizon scans and proactive management can reduce future impacts, however, none or reactive responses still seem to be the standard. In this session researchers will provide case studies of IAS, assess their impact and discuss management options.
13:30	Animal movement and migration: pressures and adaptation to global change (Thomas Lameris, Royal Netherlands Institute for Sea Research)	The ecology of the microbiome and its evolutionary consequences (Marjolein Bruijning, Princeton University, US)	Biogeography and macroecology in the Anthropocene and Quaternary. (Sietze Norder, Utrecht Univeristy)	Ecological restoration in a changing world (Eric Higgs, University of Victoria)	Predicting the risk and scope of plant invasions using species distribution and metapopulation modeling (Gerard Oostermeijer, University of Amsterdam)
13:50	Extreme and rapid range expansion by arctic geese: coping with climate change? (Kees Schreven, Netherlands Institute of Ecology)	The soil microbiome under Brazilian Atlantic Forest restoration: Are their compositional structure and potential functions being recovered? (Luis Fernando Merloti, Netherlands Institute of Ecology)	Historical biogeography and local adaptation explain population genetic structure in a widespread terrestrial orchid (Alexandra Evans, KU Leuven)	Harnessing self-facilitation among ecosystem engineers for coastal ecosystem restoratio (Tjisse van der Heide, Royal Netherlands Institute for Sea Research)	First results of testing the Ecosystem Resilience Approach (ERA) to control the invasive Australian swamp stonecrop (*Crassula helmsii*) in the Netherlands (Janneke van der Loop, Radboud University Nijmegen)
14:10	Equal survival and reproductive parameters between short- and long-distance migrating lesser black-backed gulls (Rosemarie Kentie, University of Amsterdam)	Digging deep into *Arabidopsis thaliana* roots: quantifying the rhizosphere effect along a soil to-root gradient (Sanne Poppeliers, Utrecht University)	Ecological legacies in the rainforest of Suriname (Nina Witteveen, University of Amsterdam)	Beetle diversity in Meijendel: historical data and an outlook into the future (Lia Hemerik, Wageningen University and Research)	A review of *Hydrocotyle ranunculoides*: The potential risks for bank restoration in waterways. (Elizabeth Koppenaal, FLORON)
14:30	Short Break (Air / Fire)				
14:40	The mysteries of mass-migrating bumblebees (Thijs Fijen, Wageningen University)	Weeds as auxiliary plants for crops: the role of their mycobiota for sustainable agriculture (Jie Hu, University of Rennes)	From phylogenetic data to island dynamics and back (Rampal Etienne, University of Groningen)	When the cat's away, the birds will play (Chris Smit, University of Groningen)	Do feeding-related functional traits predict the invasive success of alien freshwater fishes? (Leo Nagelkerke, Wageningen University)

15:00	Seasonal differences essential for accurate bird migration forecasts for conservation and flight safety (Bart Kranstauber, University of Amsterdam)	Is the aphid microbiome affecting the success of biological control? (Mariska Beekman, Wageningen University)	The robustness of a simple dynamic model of island biodiversity to geological and eustatic change (Pedro Santos Neves, University of Groningen)	Introducing the Nature Futures Framework for more positive futures for nature and people (Rob Alkemade, Wageningen University)	Invasion pathways and public health risks of the raccoon and its roundworm *Baylisascaris procyonis* in the Netherlands (Miriam Maas, National Institute for Public Health and the Environment)
15:20	Terrestrial Mammal Responses to COVID-19 Lockdowns (Marlee Tucker, Radboud University Nijmegen)	Closing the loop: use of insect residual streams to improve soil health (Azkia Nurfikari, Netherlands Institute of Ecology)	Macroevolutionary impact of humans on birds and mammals of the Caribbean, Madagascar and New Zealand (Luis Valente, Naturalis Biodiversity Center)	Rewilding to bend the curve of biodiversity decline (Liesbeth Bakker, Netherlands Institute of Ecology / Wageningen University & Research)	Genetics of invasive feral swine in the US (Niek Barmentlo, Wageningen University)
15:40	**Coffee and tea (Air / Fire)**				
	Earth	**Water**	**Room 21**	**Rooms 2 & 3**	**Rooms 10 & 11**
16:00	**Parallel 2a: Animals adjusting to a rapidly changing world**	**Parallel 2b: Patterns and processes aiding ecosystem resilience**	**Parallel 2c: Modelling ecology**	**Parallel 2d: Viral ecology**	**Parallel 2e: Workshop series**
	Conveners: 1. Bart Nolet (Netherlands Institute of Ecology / University of Amsterdam) 2. Jan van Gils (Royal Netherlands Institute for Sea Research)	*Conveners:* 1. Loreta Cornacchia (Royal Netherlands Institute for Sea Research) 2. Johan van de Koppel (Royal Netherlands Institute for Sea Research) 3. Max Rietkerk (Utrecht University)	*Conveners:* 1. Monique de Jager (Netherlands Institute of Ecology) 2. George van Voorn (Vrije Universiteit Amsterdam)	*Conveners:* 1. Kyle Mason-Jones (Netherlands Institute of Ecology) 2. Marcelle Johnson (Netherlands Institute of Ecology / Wageningen University)	
	Environmental changes occur more rapidly than ever before as a result of direct and indirect human effects. In fact, changes are so fast that we as ecologists can study the way organisms are responding. In this session, we want to show examples of animals trying to cope by behavioural, physiological or somatic changes, with an emphasis on empirical evidence.	Whether ecosystems will dramatically change when climate change pushes them beyond a tipping point is an ever more pressing problem for society. Recent studies point out that ecosystem complexity, e.g. in the form of the spatial patterns that are characteristic of many natural systems, can prevent tipping points to occur, and hence can dramatically increase ecosystem resilience. In this session, we will facilitate talks dealing with adaptations of ecosystems to climate change and other human-induced stresses.	Where experiments and observations fall short, ecological modelling is an indispensable tool to research ecological theories and hypotheses. Using a range of different models including simple cellular automatons, partial-differential equations, and individual-based models, we can provide a better view into the underlying mechanisms of ecological processes or predict the effects of different scenarios. In this session, we will show a diverse line-up of (young) researchers who creatively solve their research questions using models.	Viruses are mostly studied for their pathogenic effects, but their global impact reaches much further. Viruses are everywhere in the biosphere, with profound implications for host population dynamics, evolution and ecosystem function as well as for crop, livestock and human health. Virus ecology is an interdisciplinary field with new frontiers emerging in systems (e.g., soil) and approaches. This session will foster exchange between different perspectives and integration with broader ecological research. Any submission that considers viruses in their ecological context is welcomed.	

16:00	Migratory birds adjusting to a rapidly changing Arctic (Bart Nolet & Jan van Gils, Netherlands Institute of Ecology)	Pathways of resilience in complex systems (Max Rietkerk, Utrecht University)	Impact of chemical contamination on aquatic regime shifts: a model based study (Swarnendu Banerjee, Utrecht University)	Highly pathogenic avian influenza in wild birds in Europe (Ron Fouchier, Erasmus University Medical Center)	**Workshop I:** "Talking to the press" (Gert van Maanen, Editorial Bionieuws) In this one-hour workshop you will be informed about how to prepare yourself to give an interview, what to do and not to do and how to see to it that your message comes across best.
16:20	Food for thought: dietary expansion facilitates the persistence of a large frugivore in fragmented tropical forest (Nacho Villar, Netherlands Institute of Ecology)	Using deep learning and imagery to identify ecosystem resilience indicators from temporal and spatial patterns of plants and herbivores (Rebecca James, Wageningen University and Research)	Survival modelling as part of an Adaptive Flyway Management Programme for the barnacle goose (Lisenka de Vries, Netherlands Institute of Ecology)	Virophages and retrotransposons colonize the genomes of aquatic flagellates (Thomas Hackl, University of Groningen / Max Planck Institute for Medical Research)	
16:40	Increasing winter temperatures change hibernation site use in the Western barbastelle (Luc De Bruyn, Research Institute for Nature and Forest)	Soil resistance and recovery during Neotropical forest succession (Masha van der Sande, Wageningen University and Research)	Periphyton shading dynamics determines success of submerged macrophytes in temperate shallow lakes (Alena Gsell, Netherlands Institute of Ecology)	Antarctic Viruses: seasonal diversity and dynamics (Goncalo Piedade, Royal Netherlands Institute for Sea Research)	
17:00	Short break (Air / Fire)				
17:10	Effects of recreation on deer behavior and browsing impact override those of newly established wolves (Bjorn Mols, University of Groningen)	Butterfly responses to climate change in relation to landscape configuration (Marjon Hellegers, PBL Netherlands Environmental Assessment Agency)	Estimation of collision mortality of the lesser black backed gull with an individual based model (Floor Soudijn, Wageningen University)	Viral entry into caterpillar brains to understand virus-induced hyperactivity (Simone Gasque, Wageningen University and Research)	**Workshop II:** "Choosing your research areas wisely: potential synergy between ARISE, living labs and Long-Term Ecosystem Research (LTER-NL)" (Bruno Ens and Marcel Visser) At the workshop, three research networks will be briefly introduced: ARISE (www.arise-biodiversity.nl), the living labs (www.nwo.nl/en) and LTER-NL (www.lter-nl.nl). These introductions serve as a prelude to an open discussion on ecological research sites used by these, and potentially other, research networks. We very much welcome your input and we hope that together we can explore ways in which we can create synergy between these networks.
17:30	Increasing Arctic cloud cover is expected to limit gosling growth and survival (Mo Verhoeven, Netherlands Institute of Ecology)	Can we infer dryland restoration success from remotely sensed vegetation patterns? (Yanning Qiu, Wageningen University and Research)	Interspecific dependences in macrozoobenthos abundance in the Wadden Sea (Mark Rademaker, Royal Netherlands Institute for Sea Research)	Effects of body condition and urbanisation on innate immunity in Common blackbirds *Turdus merula* (Jurrian van Irsel, Netherlands Institute of Ecology)	
17:50	The extreme migratory adjustment: stop migrating (Chiel Boom, Netherlands Institute of Ecology)	How to rebuild climate-resilient wetlands: tidal channel development in natural and constructed salt marshes (Loreta Cornacchia, Royal Netherlands Institute for Sea Research)	Lake Valkenburg: How interdisciplinary modelling efforts assist real world decision making (Lilith Kramer, Netherlands Institute of Ecology)	Costs and benefits of non-selective packaging of viral genome segments into virus particles (Mark Zwart, Netherlands Institute of Ecology)	

18:10	**Drinks (Air / Fire) and dinner afterwards (Restaurant)**
19:30	**Poster session 1: Odd-numbered posters (Air)**
21:00	**Evening Lecture: Transforming Biodiversity Governance** (**Ingrid Visseren-Hamakers**, Radboud University) Over fifty years of global conservation has failed to bend the curve of biodiversity loss, so we need to transform the ways we govern biodiversity. The UN Convention on Biological Diversity aims to develop and implement a transformative framework for the coming decades. In this evening lecture Ingrid Visseren-Hamakers will talk about what transformative biodiversity governance entails and how it can be implemented, given the complexity. The talk will be based on the recent published book " Transforming Biodiversity Governance" (Edited by Ingrid J. Visseren-Hamakers, Radboud University and Marcel Kok, PBL Netherlands Environmental Assessment Agency)

Wednesday 12 February

07:30	**Breakfast (Restaurant)**				
08:00	Registration for those coming on Day 2 (Main Entrance)				
	Earth	**Water**	**Room 21**	**Rooms 2 & 3**	**Rooms 10 & 11**
08:30	**Parallel 3a: Driving forces: Behavioural responses to anthropogenic change**	**Parallel 3b: Soil Ecology in a changing world**	**Parallel 3c: Biogeography and macroecology in the Anthropocene and Quaternary, part 2**	**Parallel 3d: Connectivity between different life stages in aquatic/marine animals**	**Parallel 3e: Open session**
	Conveners: 1. Marion Nicolaus (University of Groningen) 2. Janne Ouwehand (University of Groningen)	*Conveners:* 1. Emilia Hannula (Leiden University) 2. Elly Morriën (University of Amsterdam) 3. Ciska Veen (Netherlands Institute of Ecology)	*Conveners:* 1. Sietze Norder (Utrecht University) 2. Kenneth Rijsdijk (University of Amsterdam) 3. Majoi de Novaes Nascimento (University of Amsterdam)	*Conveners*: 1. Ingrid Tulp (Wageningen University & Research) 2. Klemens Eriksson (University of Groningen) 3. Allert Bijleveld (Royal Netherlands Institute for Sea Research)	*Conveners*: 1. Laurens Poorter (Wageningen University & Research)
	Anthropogenic disturbance is widely affecting ecosystems, and challenges organisms to adapt to those changes. Behavioural responses are typically faster than genetic, evolutionary adaptations. Yet, distinguishing whether behavioural changes are true genetic adaptations, or due to phenotypic plasticity is often less clear. This session will bring together studies on behavioural responses to environmental changes. We particularly welcome experimental approaches, such as common garden experiments, aimed at unravelling the underlying adaptive mechanisms.	Soils provide most ecosystem services we rely on. However, the soils, the life in them – and the functions they provide – are severely affected by global changes. In this session we discuss human impacts on soil ecology and functioning and welcome submissions related to for example pollution, climate change, land-use, and invasive species.	Biodiversity is unequally distributed across the globe. Biogeographers and macro-ecologists try to understand the underlying sources of this variation. The aim of this session is to explore the contribution of climate, geography, and human activities shaping the spatial and temporal variation in biodiversity.	Hidden under the water's surface, fish undertake migrations at various spatial scales ranging from local streams to oceans. As different life stages often require different habitats, connectivity between areas used by fishes throughout their life is crucial to fulfill their life cycle and ultimately sustain populations. In this session we welcome different contributions on this topic that may encompass the entire aquatic and marine realm.	Open Session

08:30	The role of genes and early-life environment in shaping migration routes of Eurasian Spoonbills (Tamar Lok, Royal Netherlands Institute for Sea Research)	Watching the soil with Artificial Intelligence: Earthworm and springtail interactions during drought (Anne Krediet, Vrije Universiteit Amsterdam)	Variability of past human legacies in north-western Amazonian forest plots (Britte Heijink, University of Amsterdam)	The role of spatial habitat heterogeneity as driver for diversity and abundances of young-of-the-year riverine fishes (Twan Stoffers, Wageningen University and Research)	Genomic analyses point to a low evolutionary potential of prospective source populations for assisted migration in a forest herb (Frederik Van Daele, KU Leuven)
08:50	Home-range behaviour of Pied Flycatchers (*Ficedula hypoleuc*a) in relation to small-scale vegetation green-up within a West-African non-breeding site (Wender Bil, University of Groningen)	Earthworms as invasive species in boreal forests (Justine Lejoly, University of Alberta)	Exploring the trade-off between productivity and animal diversity in European forests (Calyne Khamila, University of Twente)	Fish movements and habitat selection in response to lake restoration project Marker Wadden (Casper van Leeuwen, Radboud University Nijmegen)	Light competition and tree height growth during tropical forest succession (Tomonari Matsuo, Wageningen University and Research)
09:10	Human-induced isolation causes rapid behavioral divergence with genetic underpinnings in resident and migrant sticklebacks (Aparajitha Ramesh, University of Groningen)	Self-organization of microbial communities and their functioning is influenced by crop rotational diversity (Lilia Serrano Grijalva, Netherlands Institute of Ecology)	Assessing phytolith composition across vegetation types in the Netherlands (Iris de Wolf, University of Amsterdam)	Urban glass eels in a man-made fragmented catchment: migration from large ship locks in the North Sea Canal to Amsterdam and surrounding polders (Ben Griffioen, Wageningen University)	Growth responses to severe droughts for assessment of forest growth potential under future climate in the Netherlands (Meike Bouwman, Wageningen University and Research)
09:30	Short Break (Air / Fire)				
09:40	Both genetic and plastic effects underlie phenotypic differences between rural and urban great tit (*Parus major*) populations (Kees van Oers, Netherlands Institute of Ecology)	The interplay between soil nutrients, mycorrhizal fungi and the common juniper (Rik Veldhuis, University of Groningen)	Understanding the relationship between dispersal and range size (Adriana Alzate, German Centre for Integrative Biodiversity Research)	Continuous acoustic measurements: the behaviour and occurrence of small pelagic fish in the inlet of the Wadden Sea revealed (Margot Maathuis, Wageningen University and Research)	Plant and plot-level diversity of chemical profiles in a tansy plant field population influences aphid occurrence (Lina Ojeda-Prieto, Technical University of Munich, Germany)
10:00	The effects of Artificial Light At Night on plant-insect interactions (Robin Heinen, Technical University of Munich)	The effect of salinization on natural floating fen biogeochemistry and plant community (Milou Huizinga, Vrije Universiteit Amsterdam)	Dutch landscapes are losing insect-pollinated plants (Kaixuan Pan, Leiden University)	Synchrony in plaice larval supply to European coastal nurseries by different North Sea spawning grounds (Henk van der Veer & Suzanne Poiesz, Royal Netherlands Institute for Sea Research)	FSC-certified forestry benefits large and critically endangered wildlife compared to non-FSC (Joeri Zwerts, Utrecht University)
10:20	Using microphone arrays and LiDAR to study the response of bats to artificial light in forest edge habitat (Claire Hermans, Netherlands Institute of Ecology)	10 years soil nutrient chemistry of a rewetted and managed peatland: implications for wet peatland use (Ralph Temmink, Utrecht University)	The future of biogeographical research in the Netherlands and Belgium (Sietze Norder, Utrecht University)	Temporary summer residency of migratory fishes in the western Dutch Wadden Sea (Jena Edwards, Royal Netherlands Institute for Sea Research)	Bugs at your service: recent insights into biocontrol and pollination in crop production systems (Felix Bianchi, Wageningen University and Research)
10:40	**Coffee and tea (Air / Fire)**				
11:00	**Poster Session 2: Even-numbered posters (Air)**				
12:30	**Lunch (Restaurant)**				

	Earth	Water	Room 21	Rooms 2 & 3	Rooms 10 & 11
13:30	**Parallel 4a: Aiding nature restoration by facilitation**	**Parallel 4b: Carbon and nutrient cycling**	**Parallel 4c: Research Infrastructures – Making Science Happen**	**Parallel 4d: Coastal ecology**	**Parallel 4e: Workshop series**
	Conveners: 1. Ralph Temmink (Utrecht University) 2. Jasper Wubs (Netherlands Institute of Ecology) 3. Bjorn Robroek (Radboud University Nijmegen)	*Conveners*: 1. Mandy Velthuis (Radboud University Nijmegen) 2. Suzanne McGowan (Netherlands Institute of Ecology)	*Conveners*: 1. Niels Raes (Naturalis Biodiversity Center) 2. Elaine van Ommen Kloeke (Naturalis Biodiversity Center)	*Conveners:* 1. Beatriz Marin-Diaz (Royal Netherlands Institute for Sea Research) 2. Janne Nauta (University of Groningen) 3. Katrin Rehlmeyer (University of Groningen) 4. Rens Cronau (Radboud University Nijmegen)	
	Facilitative interactions in ecological communities have received considerable attention in the last three decades, especially in the context of plant community ecology and global climate change. Break-through research has highlighted that facilitation can also play an important role in the restoration of ecosystems such as dunes, salt marshes and wetlands. This session will bring together researchers that study facilitation in the light of ecosystem restoration. We welcome submissions on all species, habitats and spatial scales.	Anthropogenic carbon emissions, alongside eutrophication are exerting widespread pressures on aquatic ecosystems. Fundamental knowledge on the dynamics of carbon and nutrients is required to understand their ecological impacts and the ecosystem-scale consequences for net carbon storage and efflux. This session therefore welcomes presentations on the cycling of these elements, from both an ecological and biogeochemical perspective. We invite a variety of speakers that work on different processes, ranging from primary production to decomposition.	After almost 20 year of investments Europe now has at its disposal a rich landscape of Research Infrastructures (RIs) covering all scientific domains. Next to European RIs like DiSSCo, eLTER and LifeWatch ERIC, the Netherlands is developing its national RI ARISE and is a voting participant in the Global Biodiversity Information Facility – GBIF. This session will highlight the recent scientific advances of RIs. We welcome contributions on RIs and scientific studies using RI mediated data.	Coastal ecosystems are essential to human life and nature quality for the many ecosystem services they provide, such as habitat for biodiversity, carbon storage and coastal protection. Almost half of the population worldwide lives or recreates in coastal areas and depends on these dynamic ecosystems. However, these ecosystems are highly threatened and face rapid degradation due to anthropogenic pressures. This session will focus on understanding the functioning of coastal ecosystems and which drivers may provoke changes in their dynamics. A good understanding of ecosystem functioning is essential for correct management, conservation and restoration, and could provide opportunities in our ever changing coastlines.	

13:30	Plant facilitation: linking ecological theory to management action to aid nature restoration (Rob Brooker, The James Hutton Institute, UK)	Can a living fossil save our soils? (Renske Vroom, Radboud University Nijmegen)	20 years of the Global Biodiversity Information Facility (GBIF) and the importance of citizen science (Niels Raes & Dylan Verheul, Naturalis Biodiversity Center & 2Observation International / Waarneming.nl)	Two-way facilitation between tube-building polychaetes and mussels (Janne Nauta, University of Groningen)	**Workshop III:** "Transformative Science" (Sven Teurlincx and Lilith Kramer) In this workshop we will explore how we can go from a status quo social-ecological system and transition to a new desirable future. We will do so through application of the three horizons approach. In this approach we define three horizons, the current state (H1), the transition pathway towards that state (H2) and the desired future state (H3). Together we will explore this method as a way of envisioning new futures within the context of the IPBES Nature Futures Framework.
13:50	Making sense of plant-soil biota interactions for nature restoration (Jasper Wubs, Netherlands Institute of Ecology)	Co-composting rose waste, assessing the potential as a sustainable waste management strategy (Evy de Nijs, University of Amsterdam)	Catalogue of Life: A global infrastructure for taxonomic names services (Olaf Bánki, Naturalis Biodiversity Center)	Herbivory as a driving force of seagrass species composition and resilience in Caribbean seagrass ecosystems (Fee Smulders, Wageningen University and Research)	
14:10	Local perennial plants affect occurrence and traits of annual grasses along an environmental gradient (Megan Korte, University of Groningen)	Aquatic plants can counteract eutrophication and greenhouse gas emission by wastewater effluent polishing (Lisanne Hendriks, Radboud University Nijmegen)	DiSSCo - Weaving Natural Scientific Collections into the Web of Environmental Data (Wouter Addink, Naturalis Biodiversity Center)	Benthic biodiversity patterns in the Dutch Wadden Sea (Oscar Franken, University of Groningen / Royal Netherlands Institute for Sea Research)	
14:30	Short Break (Air / Fire)				
14:40	How facilitation by an unpalatable rush affects the invasive grass *Elytrigia atherica* in a salt marsh (Isabelle Buyens, University of Groningen)	Multiple-effects of combatting eutrophication on CH4 emissions from a small pond: macrobiological, microbiological and biogeochemical insights (Quinten Struik, Radboud University Nijmegen)	UNLOCK – integrated biodiscovery-, bioreactor- and FAIR data facilities to unlock microbial diversity for society (Peter Schaap, UNLOCK consortium)	Identifying bottlenecks for subtidal eelgrass growth in the Dutch Wadden Sea (Katrin Rehlmeyer, University of Groningen)	**Workshop IV:** "The perfect Camera Traps for Ecologists: a brainstorm session" (Lennart Suselbeek) Camera traps have been around for many years and are commonly used in ecological research. Despite their common use and applications in the field, a multitude of challenges occur in most commercially available systems. At the same time, new smart technologies combined with small open-source microprocessor computers offer ample opportunities for the development of a new generation of camera traps, particularly geared towards ecologists / scientists. In this session, we would like to spark an open discussion about these new developments and opportunities in the field, and to connect these to the challenges presented with camera trap use in the field.
15:00	Facultative mutualism facilitates European seagrass meadows (Jimmy de Fouw, Radboud University Nijmegen)	Greenhouse gas emissions from dredged material and potential mitigation measures: an experimental approach (Judith van der Knaap, Radboud University Nijmegen)	What radar can do for biodiversity monitoring in the sky (Bart Kranstauer, University of Amsterdam)	Seagrass-ragworm interaction reducing seagrass survival by tube construction is mitigated by a dual-protection interaction with epiphyte grazers (Rens Cronau, Radboud University Nijmegen)	
15:20	Five years Marker Wadden: creating gradients for lake restoration (Joep de Leeuw, Wageningen University and Research	Greenhouse gas emissions from Dutch inland waters, how to manage to reduce emissions? (Bob Brederveld, Deltares knowledge institute)	ARISE – Building an infrastructure for species recognition and biodiversity monitoring (Elaine van Ommen Kloeke, Naturalis Biodiversity Center)	Establishment of clonal expanding cordgrass: Better safe than sorry (Clea van de Ven, University of Groningen / Royal Netherlands Institute for Sea Research)	

15:40	**Coffee and tea (Air / Fire)**
16:00	**Earth**
	Plenary 2: "Ecological restoration" This plenary will focus on wicked problems in current ecological restoration e.g. how to incorporate multiple stakeholder perspectives and interests into grassland restoration as well as how we can use legacy effects of which plant species arrive first to create desired multifunctional outcomes, without compromising the aim to increase biodiversity as much as possible.
16:00	**Restoring altered seascapes - Linking theory and practice in coastal restoration** (**Laura Govers**, University of Groningen, Netherlands Institute for Sea Research)
16:45	**Tropical Forest Restoration: the power of natural regeneration** (**Frans Bongers**, Forest Ecology and Forest Management, Wageningen University)
13:30	**Awards and Closing Ceremony (Earth)**
18:00	**Farewell drinks (Air / Fire)**
18:30	**Dinner (Restaurant)**
19:30	**End / Travel Home**

NAEM 2022

Presentation Abstracts

Plenary Session 1

Animal migration

Animal migration is a spectacular natural phenomenon, resulting in the redistribution of entire populations and billions of organisms. This session addresses some of the adaptations and challenges facing animal migrations when traversing hundreds to thousands of kilometers over land or in the air, and shows how different techniques can be used to inform us about how, when, where and why animals move.

1. Integrating animal movement with the conservation and management of ecosystems: behavioural and physiological insights from the Serengeti wildebeest migration.

Grant Hopcraft, Institute of Biodiversity, Animal Health & Comparative Medicine, University of Glasgow

The movement of animals away from disturbed areas provides useful indicators of an ecosystem under pressure. Typically, animal movement studies combine GPS data with environmental covariates to understand the how animals decide whether to remain or depart from an area. These behavioural responses are the product of calculated decisions in which animals weigh up the availability of resources and risks against their internal requirements (i.e. starving animals may respond differently to risk than satiated animals), however estimating the physiological condition of free-living animals is challenging. In this talk we present our work from Serengeti in which we use metabolites deposited in the tail hair of GPS-collared migratory wildebeest to recreate their physiological timelines of starvation and pregnancy cycles. This approach provides a deeper understanding of how the internal state of the animal alters their behavioural decisions, such as whether to stay or move. It also allows us to investigate how animals react to management interventions and human activity both at the edges of ecosystems (where migratory wildebeest interact with people) and in the core protected areas (where migratory wildebeest interact with tourism infrastructure). By linking the movement of animals to their internal state we gain deeper insights about which management interventions are working and how animals are responding both physiologically and behaviourally to human activities. The next challenge is to integrate these metrics with long-term demographic responses, such as survival and viability.

2. Migration through the troposphere

Judy Shamoun-Baranes, Institute for Biodiversity and Ecosystem Dynamics, University of Amsterdam

During migration, birds may transverse oceans, deserts, cities, forests and mountains. Migration might require incredible feats of endurance or small nightly hops from one resting area to the next. During these migratory journeys birds must travel through the troposphere, a turbulent aerial environment where most of Earth's weather occurs. This talk explores some of the strategies birds have for coping with and taking advantage of the daily, seasonal and regional dynamics of the troposphere. Individual tracking through bio-logging, measuring aerial fluxes with radar and simulation modelling are valuable tools for studying interactions between birds and the aerial environments they transverse during their migratory journeys. How birds utilize the aerial environment can shape migration routes as well as diurnal and seasonal timing of migration. Weather and circulation patterns can create barriers as well as corridors for migrants. Understanding how atmospheric dynamics influence migratory flights can also provide opportunities for reducing human-wildlife conflicts that occur in environment increasingly encroached by human activities.

Plenary Session 2

Ecological restoration

This plenary will focus on wicked problems in current ecological restoration e.g. how to incorporate multiple stakeholder perspectives and interests into grassland restoration as well as how we can use legacy effects of which plant species arrive first to create desired multifunctional outcomes, without compromising the aim to increase biodiversity as much as possible.

1. Restoring altered seascapes - Linking theory and practice in coastal restoration

Laura Govers, University of Groningen, Netherlands Institute for Sea Resech

Natural ecosystems are undergoing rapid change, resulting in functional losses and disruptions to associated ecosystem services. Ecological restoration provides a hopeful and positive outlook to halt and reverse these losses. The need for restoration has recently been acknowledged by the UN 'Decade on Ecosystem Restoration'. This recognition has lent a new urgency to ecosystem restoration, leading to skyrocketing expectations for successful restoration outcomes. However, in coastal ecosystems, restoration successes targeting habitat-building species such as shellfish reefs, salt marshes, seagrasses and mangroves are generally low. Hence, there is a great need to advance knowledge and develop tools that can contribute to coastal restoration practice. In this talk, I want to take you along on a journey and highlight how linking ecological theory to practice can lead to successful restoration outcomes in a heavily altered seascape (the Dutch Wadden Sea), emphasizing the value of connecting science to practice for the advancement of both.

2. Tropical Forest Restoration: the power of natural regeneration

Frans Bongers, Forest Ecology and Forest Management, Wageningen University

Tropical forests deliver many ecosystem services, both locally and (inter)nationally. Not only products and pleasure, but also climate stabilization and climate change mitigation. During the past decades, however, their areas dwindle fast, as do their qualities, impacting their contributions. Increase of forested areas and forest quality therefor is highly needed, along with restoration of other ecosystems. This urge led the United Nations to declare 2021-2030 the Decade of Ecosystem Restoration.

What is forest restoration? How does it work? Where can it be done? And what do we need to do to reach set goals? In this presentation I will address these questions with a focus on restoration based on natural regeneration. The key systems in the spotlight are (1) fully natural regeneration on formerly used agricultural land, (2) assisted natural regeneration, and (3) farmer managed natural regeneration. Using examples of results of our work in this field in various tropical countries (among others Mexico, Brazil, Ethiopia) and in both wet and dry systems I will explore restoration pathways, main driving factors, and important bottlenecks. I will show that the potential of natural regeneration is high, but also that more focused action is needed to use this potential to the max. We need to use the power of natural regeneration to reach restoration goals. I will put our results in the light of the currently fast changing international developments, and also suggest possible directions of new research. The urge, the stakes, and the international pressure are high. What do we need to do to speed up tropical forest restoration?

Parallel Session 1

1a: Animal movement and migrations: pressures and adaptation to global change

Conveners: Thomas Lameris (Royal Netherlands Institute for Sea Research)
Fleur Visser (University of Amsterdam/Royal Netherlands Institute for Sea Research)
Frank van Langevelde (Wageningen University & Research)

1. Animal movement and migration: pressures and adaptation to global change

Thomas Lameris, Fleur Visser, Frank van Langevelde
Royal Netherlands Institute for Sea Research

Many animals are adapted to a life on the move, and thereby form a fundamental part of multiple ecosystems along their migration routes. Due to increasing human pressures such as anthropogenic barriers and stressors in migration corridors, over-harvesting and climate warming, migratory animals are facing increasing risks during their migrations, causing migratory populations to decline or to switch to a residential lifestyle. In this session we welcome all talks discussing animal migration in the light of environmental change.

2. Extreme and rapid range expansion by arctic geese: coping with climate change?

Kees Schreven, Jesper Madsen, Michiel P. Boom, Leif Nilsson, Bart A. Nolet, Jorma Pessa
Netherlands Institute of Ecology

The Arctic has seen the fastest rate of climate change on earth. Increasing temperatures lead to earlier springs and in response organisms may advance their phenology or colonize colder areas with later springs. For migratory birds, both ways of adjustment may be challenging as arctic spring timing cannot be forecasted from temperate locations, and range expansion is usually a slow gradual process. However, here we show with GPS-tracking that Pink-footed Geese (*Anser brachyrhynchus*) from Svalbard have expanded their range 1000 km eastwards by colonizing Novaya Zemlya as breeding ground. This new subpopulation uses more eastern migration stopovers and has grown to 3-4000 birds in only 10 years, by intrinsic growth and continued immigration from the traditional western route (60-75,000 birds). Novaya Zemlya and Svalbard have both warmed up, but Novaya Zemlya is colder (similar to Svalbard 40 years ago). Moreover, the rate of spring advance has been more uniform along the new eastern route than along the traditional western route, enabling geese to keep in better pace with spring. We hypothesize that the geese' flocking behaviour (particularly, the mixing with Taiga Bean Geese) resulted in social transmission of migration behavior and has been key to this fast development. Thus sociality may provide ecological rescue in a rapidly changing world.

3. Equal survival and reproductive parameters between short- and long-distance migrating lesser black-backed gulls

Morgan Brown, Rosemarie Kentie, Kees Camphuysen, Judy Shamoun-Baranes
University of Amsterdam

Migrating animals show remarkable diversity in their migration strategies, even between individuals from the same population. Migration is often assumed to be costly in terms of time, energy and mortality risk. These costs are expected to be balanced by increased survival due to higher quality wintering areas at lower latitudes. Alternatively, unequal fitness between strategies may occur if migration strategy is dependent on an individual's condition or if wintering area quality has rapidly changed, for instance due to anthropogenic modifications to the landscape. In this study we compared reproductive parameters and apparent survival of lesser black-backed gulls (*Larus fuscus*) breeding in the Netherlands and whose winter range extends from the UK to West Africa, resulting in one-way migration distances that differ by more than 4500 km. Although previous studies on this species found long-distance migrants arrive later at the breeding grounds, we found no evidence of reduced reproductive performance. We also found that migration distance had no effect on survival, which corresponds to earlier results showing that this species' annual energy expenditure is similar across migration strategies. Combined, this suggests equal fitness payoffs across strategies.

4. The mysteries of mass-migrating bumblebees

Thijs Fijen
Wageningen University

Bumblebees are one of the most commonly studied pollinators, but they are declining in large parts of their distribution. Whether bumblebees can cope with anthropogenic disturbances such as climate change and habitat loss depends largely on their dispersal capacity, which is generally considered to be only a few kilometres. The open-access database trektellen.org contains ten daily counts of >1000

migrating queens past single points in the Netherlands, and one in the UK (total bumblebee records 65,430; range 1-11,142 individuals), mostly in early-Spring. Surprisingly, bumblebee mass-migration events are poorly documented in the scientific literature and may have been overlooked. Bumblebees were observed flying at sea, coming from sea, and flying towards the sea, showing that they can cross large water bodies. The wind direction might have helped to concentrate migration at landscape bottlenecks. On one day, bumblebee mass-migration was documented on two sites located 200 kilometres apart. Together with the concentrated and directional flight this suggests that they can migrate for several hundreds of kilometres. However, a lot is still unknown, and we have yet to learn what the drivers of mass-migration are, and what the implications are of these events for bumblebee conservation.

5. Seasonal differences essential for accurate bird migration forecasts for conservation and flight safety

Bart Kranstauber, Willem Bouten, Hans van Gasteren, Judy Shamoun-Baranes
University of Amsterdam

During their annual migrations billions of birds encounter human infrastructure. To mitigate the risks of encounters for both humans and birds temporary measures as wind turbine shutdowns and flight safety warnings are implemented. To implement these measure forecasts for the expected intensity of migration are essential. Monitoring bird migrations is challenging, especially over large spatial and temporal ranges. Most bird observation techniques are limited, for example, by darkness or in altitudinal range. In recent years radar observations are more frequently used to monitor bird populations. Weather radars are an especially powerful tool as they operate continuously and cover a large area. We present a predictive model for bird migration designed to issue flight safety warnings for military aviation. Using 10 years of migration data we predict the density of migrants based on weather conditions. Predictions from the ensemble model are evaluated for years omitted from the dataset and compared between the spring and fall migratory season. We find differences in both the important environmental variables and the predictability between seasons. In fall the accumulation of migrants due to wind conditions is more important and environmental conditions contribute more to consistent predictions.

6. Terrestrial Mammal Responses to COVID-19 Lockdowns

Marlee Tucker
Radboud University

The global COVID-19 pandemic has had a significant impact on human behaviour, with many governments implementing lockdown strategies to prevent the spread of the disease. These tragic events provide a unique opportunity to examine how humans impact biodiversity, specifically animal behaviour. I will present some recent work investigating how terrestrial mammals have responded to the initial lockdowns in 2020. Combining GPS data - representing 43 species on 5 continents - with species traits, environmental data and lockdown strictness, we compared movement and habitat use during the 2020 lockdowns with a baseline period in 2019. We found an average decline in hourly movements of 12%, indicating reduced disturbance effects. On a 10-day time scale, animals travelled on average 73% farther under strict lockdown conditions, suggesting increased landscape permeability with decreased human presence. In addition, locations of animals were on average 36% closer to roads in areas of high human impact. Overall, lockdown conditions rapidly altered the spatial behaviour of terrestrial mammals and highlight the significant impact of human activities on wildlife worldwide.

1b: Ecology of the microbiome

Conveners: Marjolein Bruijning (Princeton University)
Shumaila Rasool (Netherlands Institute of Ecology)
Dharani Kamalachandran (Utrecht University)

1. The ecology of the microbiome and its evolutionary consequences

Marjolein Bruijning
Princeton University, United States

Eukaryotic hosts harbor highly diverse microbial communities, and it is increasingly clear that these communities play a pivotal role in the ecology and evolution of their hosts. Looking ahead to upcoming talks of this session, I will present how these fit within the state-of-the-art of the field of microbiome research, and provide my perspective on how we can use theory and modeling to advance the field. I focus on three broad questions. First, how do microbiome communities assemble? I outline how we can use ecological and evolutionary theory to study key processes, such as priority effects, host selection and microbial competition and transmission. I show how hosts may benefit from different routes of microbial transmission, including the transmission from parents to offspring. Second, how does the microbiome influence host performance? Microbiome composition shapes many fitness-related traits of their hosts, for example, pathogen resistance, stress-tolerance and metabolism. However, the mechanistic pathways through which this occurs are largely unknown. I show how we can use ecological consumer-resource models to improve our understanding of microbiome-mediated protection against a common plant pathogen. Lastly, given our current knowledge on the processes governing microbiome assembly and on the links between microbiome composition and host performance, can we harness the potential of the microbiome to benefit food production and public health?

2. The soil microbiome under Brazilian Atlantic Forest restoration: Are their compositional structure and potential functions being recovered?

Luis Fernando Merloti
Netherlands Institute of Ecology

The Brazilian Atlantic rainforest biome has lost around 87% of its natural vegetation, with these areas being predominantly converted to different land-use systems, such as pastures and sugarcane plantations. However, large-scale ecological restoration programs in Brazil have begun to transform degraded lands into young native ecosystems using different restoration strategies, but until now, little is known about forest restoration's impact on the soil microbiome and its functional role in this environment. Thus, we investigated the effect of Active and Assisted Forest restoration methodologies with different time scales (Early-, Intermediate- and Late-stages) on soil microbial communities (Fungi, Bacteria-Archaea, and Protist-Nematode) in the Atlantic Forest region in São Paulo state, Brazil. We noticed that the soil microbiome structure was not statically similar to any of the reference forests (based on PERMANOVA, $P<0.05$, Bray-Curtis distance). In addition, the soil community's diversity and richness were similar to the Secondary-Degraded reference forest and higher than Native-Conserved and Native-Degraded reference forests (ANOVA, Tukey test $P<0.05$, followed by Bonferroni correction). However, when the soil multifunctionality analysis was performed, it was found that the Late-stage Forest restored by Assisted methodology was similar to the Native-Conserved reference forest (based on PERMANOVA, $P>0.05$, Bray-Curtis distance). The results indicated that the soil microbiome functions in the Atlantic Forest could be restored mainly by combining planted and natural forests as the Assisted method. Together, our results provide information to outline better methodologies to recover the above and below-ground communities of tropical forests in a global scenario of intense deforestation and climate change.

3. Digging deep into Arabidopsis thaliana roots: quantifying the rhizosphere effect along a soil to-root gradient

Sanne W.M. Poppeliers, José Luis López, Bas Dutilh, Corné Pieterse, Ronnie de Jonge
Utrecht University

Plants secrete a complex array of organic compounds, about a third of their photosynthetic products, into the surrounding soil, the rhizosphere. As a result, concentration gradients are established from the roots into the bulk soil. Soil microbes benefit from the root exudates for their survival and propagation, and consequently rhizosphere microbial community composition follows the gradient of available compounds, oftentimes referred to as the rhizosphere effect. How microbial community composition differs along this soil-root gradient on a fine-grained scale has not been well described, yet such insights would allow us to underpin the critical, ecological rules underlying root community assembly. Therefore, here we harvested the roots of single Arabidopsis thaliana plants grown in natural soil in a way such that we could interrogate community assembly across consecutive, fine-grained, 'compartments'.

To this end, we stripped the roots of more and more soil and adhering microbes and compared the bacterial communities to each other and to unplanted soil. We found that the strength of the rhizosphere effect is dependent on root proximity and that microbial communities closer to the roots harbor phylogenetically, physiologically, and likely, functionally redundant microbes. As we sampled closer to the roots, microbial community assembly became less random and clearly more driven by selection based processes. Surprisingly, we observed that priority effects determined which specific microbes were found on individual plants. These effects appeared independent from starting conditions as microbial communities appear to converge on the root despite different soil 'seed banks'.

4. **Weeds as auxiliary plants for crops: the role of their mycobiota for sustainable agriculture**
Jie Hu, Claire Ricono, Philippe Vandenkoornhuyse, Cendrine Mony.
University of Rennes

Weed species were treated as antagonist players for crop yields by competition for the soil resources since decades. However, positive effects of weeds on agrosystem diversity, including plant symbiotic microbial reservoir, are increasingly recognized. We developed in this study a new understanding about weed species as possible auxiliary plants.
Here, we combined a set of experiments performed both in organic agricultural fields and in controlled lab conditions. We analyzed the effect of weed species diversity and identity on wheat root mycobiota and plant performance in the field. We tested the effect of weed identity and their ability to transmit root microbiota to wheat roots, and their impact on wheat growth in lab conditions.
We demonstrated that wheat performance is weed neighbor dependent, and the diversity and composition of wheat root mycobiota was influenced by weed diversity and identity in the field. The microbial transmission of weed species to wheat roots were weed identity dependent. The wheat mycobiota modifications caused by weed presence could explain changes in plant performance.
We therefore concluded that weeds hold the potential to maintain or even manipulate the mycobiota of focal crop plants to stabilize crop yields, furthermore contribute to soil biodiversity and sustainable agriculture.

5. **Is the aphid microbiome affecting the success of biological control?**
Mariska Beekman, Helena Donner, Kathrin Barth, Marcel Dicke, Bas Zwaan, Eveline Verhulst, Bart Pannebakker
Wageningen University

Bacterial symbionts constitute an important part of the insect microbiome, and their role in insect ecology and evolution is increasingly recognized. Aphids are an important group of insect pests in agriculture. They can carry bacterial endosymbionts which sometimes protects them against parasitoid wasps. Because parasitoids are often deployed in greenhouses to biologically control aphid pests, it is hypothesized that the presence of these endosymbionts might negatively affect the success of biological control of aphids. We studied the prevalence of bacterial endosymbiont in aphids from Dutch strawberry greenhouses. We found that the most dominant aphid species *Acyrthosiphon malvae* (Mosley) is often infected with the endosymbionts *Hamiltonella defensa* (86%) and *Regiella insecticola* (54%). By curing the aphids of their symbiont infections with the use of antibiotics, we could study the effects of endosymbiont infection on the parasitism success of two commonly used biocontrol parasitoids *Aphidius ervi* and *Praon volucre*.

6. **Closing the loop: use of insect residual streams to improve soil health**
Azkia Nurfikari, Márcio Fernandes Alves Leite, Eiko Eurya Kuramae, Wietse de Boe
Netherlands Institute of Ecology

Insect farming plays an important role in a circular economy by transforming organic waste into high-value proteins. Insect production itself also generates waste: chitin-containing exoskeletons (exuviae) and excrements (frass). This residual stream is a promising soil amendment for improving soil health. Degradation of chitinous matter is known to stimulate the growth of chitin-degrading microbes naturally present in soil, which can provide protection against soil-borne diseases. Furthermore, frass decomposition has been reported to stimulate the activity of microbial decomposers, thereby locally enhancing N release from recalcitrant organic matter. This study investigates the response of indigenous soil microbes to the amendment of exuviae and frass. We also examined if the substrate-mediated shifts in microbial community can result in enhanced disease-suppressiveness against root-infecting fungal pathogen. The data revealed that the abundance of bacilli, a taxonomic group harboring many potential biocontrol strains, was significantly upshifted in amended soils. At the functional gene level, the abundance of chitinase gene carried by soil bacteria (*chiA*, family-18 glycoside hydrolase) was also increased. Greenhouse bioassay studies showed a promising outlook of insect residual stream amendment to control disease caused by Fusarium in lettuce seedlings. This study serves as a basis for the use of insect residual streams as a sustainable soil amendment.

1c: Biogeography and macroecology in the Anthropocene and Quaternary I

Conveners: Sietze Norder (Leiden University)
Kenneth Rijsdijk (University of Amsterdam)
Majoi de Novaes Nascimento (University of Amsterdam)

1. Biogeography and macroecology in the Anthropocene and Quaternary

Sietze Norder, Majoi de Novaes Nascimento, Kenneth Rijsdijk
Leiden University

The Anthropocene is characterized by an abrupt stage of global turnover of flora and fauna, caused by human induced connectivity between continents unprecedented since the breakup of Gondwana 180 My ago. This process initiated merely a few centuries ago has resulted in the global spread of human food crops, invasive species, and accelerated extinction threat of many species. In addition, the modification of landscapes and upscaling of agriculture went at the expense of habitats and niches of countless species. Biogeography is concerned with mapping and monitoring biodiversity from genes to species and understanding their spatial patterns, studying the evolutionary past to preserve and restore biodiversity. Recent advances in palaeoecology, genetics, modelling and big data analysis allow for fundamental insights into how the dynamics of natural and human induced change shaped past, present and future biodiversity. The session comprises two parts, spread over two consecutive days. During these days we will cover a wide range of topics related to biogeography and macroecology, including: biodiversity legacies of past environmental and climatic change, global change biogeography, and conservation biogeography.

2. Historical biogeography and local adaptation explain population genetic structure in a widespread terrestrial orchid

Alexandra Evans, Hanne de Kort, Rein Brys, Karl J. Duffy, Jana Jersáková, Tiiu Kull, Marc-André Selosse, Spyros Tsiftsis, Julita Minasiewicz, Hans Jacquemyn
KU Leuven

The large-scale spatial genetic structure of a species is the result of complex interactions between genetic drift, gene flow and selection, but the extent to which these processes shapes the genetic structure of contemporary populations remains unclear for many species. In this study, environmental niche modelling and genetic analyses were used to gain insight into the genetic structure and biogeographic history of the orchid *Epipactis helleborine*. Landscape genomics and allele frequency covariance analyses performed on a large single-nucleotide polymorphism (SNP) data set were used to assess the contribution of natural selection to allele frequencies, identify potential locations of admixture, and assess how post-glacial colonization dynamics contributed to the genetic structure of E. helleborine populations in Europe. Although genetic differentiation of current E. helleborine populations was relatively low, genetic signatures indicated that Italy and central Europe likely acted as important sources of genetic admixture for populations throughout Europe after the Last Glacial Maximum, while Greek populations remained relatively isolated likely due to steep elevation gradients. Spatial distribution and outlier SNPs were associated with temperature, soil characteristics, elevation, and precipitation. These results indicate that both adaptation to local environments and climatic fluctuations can influence the spatial genetic structure of wide-ranging herbaceous species.

3. Ecological legacies in the rainforest of Suriname

Nina Witteveen
University of Amsterdam

Suriname is the most forested country in the world, but deforestation due to mining activities is an increasing threat. Successful forest conservation can be achieved through the sustainable livelihoods of local communities along with insight into forest recovery dynamics. Saramaka Maroons - groups descended from escaped enslaved people - have been living in the forests of the Upper Suriname region since the late 1600s. Little is known about the Tropical Rainforest Culture (TRC) of the inhabitants from Suriname during the pre-Columbian period.
The cultural heritage of Maroons and indigenous communities is largely unknown, as are the long-term effects of their past activities on the forest (ecological legacies). To shed light on the vegetation dynamics and the cultural heritage of Saramaka Maroons, this study investigates the vegetation and fire history near a Maroon archeological site in Suriname. Phytoliths, silica microfossils that remain in the soils after plants decay, have been analyzed to reconstruct the vegetation history of the last ±2000 years. The fire history has been reconstructed using charcoal analysis. Preliminary results show deforestation, cultivation and palm enrichment took place after Maroons settled, but only within 1km distance of the archeological site. Thus, ecological legacies are likely on a local scale.

4. **From phylogenetic data to island dynamics and back**
Rampal Etienne, Pedro Neves, Luis Valente
Groningen Institute for Evolutionary Life Sciences

Island biogeography has embraced the idea that island geological dynamics (geological activity, sea level changes) can influence biota assembly on the island. Particularly, the change in area and connectivity may affect rates of extinction, speciation and colonization. Conversely, knowledge about the temporal dynamics of these processes may inform us about the geological history of the island. Here we develop an inference tool within the DAISIE modelling framework that will allow us to estimate from phylogenetic data either the parameters of the relationships between island characteristics (particularly area) and the processes of speciation, extinction and colonization for a given area trajectory through time, or to estimate the parameters of such a trajectory for a given relationship between area and the processes.

5. **The robustness of a simple dynamic model of island biodiversity to geological and eustatic change**
Pedro Santos Neves, Joshua Lambert, Luis Valente, Rampal Etienne
Groningen Institute for Evolutionary Life Sciences

The influence of the dynamic geological process that islands are subject to has long been of interest to island biogeographers. Variations in area due to island ontogeny and sea-level changes, as well as dynamics arising from the separation of continental islands from the mainland and the occurrence of land-bridges may play a role in shaping current and past island community biodiversity. However, available models of community island biogeography have so far ignored these processes by considering constant island area through time and no study has evaluated if this constitutes a source of bias. We extend current simulation methods to explicitly account for all these processes and develop a pipeline aiming to determine the presence and magnitude of such bias. We find little error when area changes linked to island ontogeny, sea-level changes and the sum of both processes are ignored. However, past connections to the mainland in younger continental islands disrupt the ability of the model to accurately make inferences on island communities. This indicates that a novel inference method is required to properly study islands that were recently connected to the mainland.

6. **Macroevolutionary impact of humans on birds and mammals of the Caribbean, Madagascar and New Zealand**
Luis Valente, Nathan Michielsen, Liliana Dávalos, Grace Saville, Voahangy Soarimalala, Steven Goodman, Alexandra van der Geer, Juan Carlos Garcia Ramirez, Nathan Upham, Rampal Etienne
Naturalis Biodiversity Center

Islands have suffered recent extinctions attributed to human activity and today many of their unique species are threatened. While the number of species lost and threatened is known, how does this translate in terms of evolutionary history? One approach is to measure the island evolutionary return time (ERT), the time it would take to restore an island's lost and threatened biodiversity under natural rates of colonisation, speciation and extinction. We measured the ERT for the bats of the Caribbean, mammals of Madagascar and birds of New Zealand, using phylogenetic data for the complete assemblages of these taxa on each island group, including extinct and recently discovered species. We find that millions of years of evolutionary history have been lost and several other millions of years are currently under threat on these islands. The ERT does not correlate well with the number of extinct/threatened species, and therefore provides useful additional information and a new perspective on the value of insular biotas for conservation, focusing on evolutionary time rather than solely on the number of species.

1d: Bending the biodiversity curve

Conveners: Nicky Faber (Wageningen University & Research)
Bart Pannebakker (Wageningen University & Research)

1. Ecological restoration in a changing world

Eric Higgs
University of Victoria

To be determined.

2. Harnessing self-facilitation among ecosystem engineers for coastal ecosystem restoration

Tjisse van der Heide
Royal Netherlands Institute for Sea Research

Ecosystem engineers – organisms that strongly modify their environment – are vital for the formation and stability of coastal landscapes. Clear examples are habitat-forming vegetation (e.g., seagrasses, salt marsh plants, dune grasses, mangroves) and reef-building organisms (e.g., corals, oysters, mussels) that attenuate wind or water flow, trap airborne or water-suspended particles, stabilize the sediment, and provide stable, spatially complex substrate. Over the last century, however, ecosystem engineers and the habitats they form have experienced massive human-induced declines. Although restoration is increasingly considered a vital tool to halt and reverse this coastal ecosystem degradation, its success is very limited (often less than 30%) and very costly compared to terrestrial restoration actions. Recent scientific advancements, however, demonstrate that by modifying transplants designs of habitat-forming engineering species from dispersed to clumped can amplify coastal restoration yields as it generates self-facilitation from emergent traits. These traits are not expressed by individuals or small clones, but emerge in clumped individuals or large clones. Moreover, follow-up studies show that by temporarily mimicking emergent traits such as sediment stabilization by dense root mats or flow attenuation by plant canopies or reef patches using crude biodegradable mimics, can 'jump-start' engineering species while using no or little donor material. Current work focuses on development of refined species-specific emergent trait-based mimics using industrial design-based conceptual approaches combined with 3D-printing techniques.

3. Beetle diversity in Meijendel: historical data and an outlook into the future

Lia Hemerik, Gijs Gerrits
Wageningen University & Research

In the dunes of Meijendel, research has been carried out to assess the occurrence of ground-dwelling invertebrates in the years 1953-1960. Sampling took place using 100 'catch cans' in a gradient from bare sand to poplar forest. However, the nearly 100,000 beetle catches havenever been systematically analysed. The dataset was only available on paper and has recently been digitized, made suitable for analysis and will soon be published on GBIF. Here, we want to present the first results of exploratory analyses. What did the beetle fauna look like back then? And what changes can be observed in the dataset as a result of the inlet of river water and/or the outbreak of myxomatosis? We also want to discuss the opportunities that this unique dataset offers with respect to comparison with the current state of the ground-dwelling beetle fauna in Meijendel.

4. When the cat's away, the birds will play

Chris Smit
University of Groningen

One of our most popular pets, the domestic cat, has devastating impacts on wildlife across the globe. In the Netherlands alone, millions of birds, small mammals, amphibians, reptiles and insects are being killed by free-ranging domestic cats at a yearly basis. While these negative effects have been known already for a very long time, one may wonder to what degree they are still acceptable at the time we are losing our biodiversity at an alarming speed. Domestic cats are already enlisted as exotic invasive in many countries, and recent studies indicate that according to European Nature Conservation law it is in fact forbidden - and it should effectively be prevented - to let cats roam free outdoors in all EU Member States. However, thus far, very little action is taken too seriously tackle this 'blind spot in the application of nature conservation law'. In this talk, I will address this sensitive issue, present various possible unconventional measures, and discuss their effectiveness for biodiversity conservation.

5. Introducing the Nature Futures Framework for more positive futures for nature and people

Jan Kuiper, Sylvia Karlsson-Vinkhuyzen, Rob Alkemade, Machteld Schoolenberg
Stockholm University

Scenarios are a powerful tool for exploring alternative futures. Most scenarios available to policy makers, however, describe further destruction of the biosphere, and thus have limited value for exploring transformative pathways that bend the curve of biodiversity. The Task Force on Scenarios and Models of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) is mandated to catalyze the development of a new generation of scenarios and models of biodiversity and nature's contributions to people. To that end, they developed the Nature Futures Framework, a pluralistic scenario framework that engages with people's diverse values of nature. The Nature Futures Framework can be used as a tool to collaboratively create positive visions for nature and people, and identify transformative development pathways to achieve these visions. The aim of this talk is to inform the audience on the latest development of Nature Futures Framework and to promote the development of more positive scenarios for nature and people by the broader researcher community.

6. Rewilding to bend the curve of biodiversity decline

Liesbeth Bakker
Netherlands Institute of Ecology, Wageningen University & Research

Rewilding is an ecosystem restoration technique aiming to give more room to natural processes. It is a form of so-called open-ended management, meaning that the outcome of rewilding is not geared towards certain pre-defined species combinations. This raises the question what the outcome of rewilding is for biodiversity? In this presentation I address how rewilding can contribute to bending the curve of biodiversity decline.

1e: Invasive alien species, tolerate or extirpate?

Conveners: Annemarieke Spitzen-van der Sluijs (RAVON / Radboud University / Netherlands Expertise Centre Exotics)
Baudewijn Ode (FLORON / Netherlands Expertise Centre Exotics)

1. Predicting the risk and scope of plant invasions using species distribution and metapopulation modeling

Gerard Oostermeijer
University of Amsterdam

Eradication of IAS is only effective in very early stages of the invasion process. Yet, governments rarely acknowledge the need to finance eradication programs before species have actually become invasive and have obvious ecological and/or economic consequences. Models may help convince policy makers, because they can show the rate and expanse of the invasion in an earlier stage. We used a combination of ecological field work with species distribution and metapopulation models to forecast the invasion of the invasive species *Eschscholzia californica* (Californian poppy) and *Pennisetum setaceum* (African fountain grass) on the Canary island Tenerife. We also modelled the effect of different eradication intensities on the invasion process. We show that our approach helps visualize the invasion process and estimate the rate and spatial extent of the invasion. The model can also help assess the effects of various management intensities, and demonstrate whether eradication is feasible at all. The results can guide managers and policy makers to design management strategies of potentially IAS in a more effective earlier stage of the invasion.

2. First results of testing the Ecosystem Resilience Approach (ERA) to control the invasive Australian swamp stonecrop (*Crassula helmsii*) in the Netherlands

Janneke van der Loop, Hein van Kleef, Laura van Veenhuisen, Joost Vogels, Rob Leuven
Radboud University / Stichting Bargerveen / Netherlands Expertise Centre Exotics

Habitats with open niches and species-poor native ecosystems are vulnerable for settlement and spread of the invasive alien species *Crassula helmsii*. Because eradication is in most cases not feasible, ecosystem-based management, the so-called Ecosystem Resilience Approach (ERA), is used to control this species.
Resilience is the ability of a community to recover after disturbances. The effectiveness of resilience in IAS management is coming from facilitating a high occupancy of niches resulting in resistance against invasion. Niche occupation depends on a number of conditions; First, abiotic conditions, which often have altered from the optimal conditions, should be restored. Secondly, native species should be able to recolonize the area. Species with a negative interaction with the IAS, such as competition, add to the invasion resistance.
The ERA targeting *C. helmsii* consists of: 1) reducing the biomass of *C. helmsii*, breaking its dominance growth. 2) stimulating the presence of native plant species to stimulate competition and a reduced resettlement and regrowth of *C. helmsii*. This can be achieved by introducing native vegetation in order to fill open niches as quickly as possible. In this presentation we describe the first experiences applying this method to reduce infestations of *C. helmsii* in the Netherlands.

3. A review of *Hydrocotyle ranunculoides*: The potential risks for bank restoration in waterways

Elizabeth C. Koppenaal, Michiel J.J.M. Verhofstad
FLORON

To improve the ecological water quality of man-made waterways, eco-friendly banks have been constructed along many artificial waterways in the Netherlands. However, these eco-friendly banks are also an adequate habitat for the invasive species *H. ranunculoides*, which is prevalent in many areas. In this review we assess if the construction of eco-friendly banks leads to increased floral and macro-faunal quality, using literature and expert knowledge. The focus of this study is on ditches and channels. For these waterways we try to disentangle if, and which type of eco-friendly bank (steep or gradual) is the best option to enhance native biodiversity, without exacerbating the presence of *H. ranunculoide*s. This will help water managers to decide if constructing an eco-friendly bank is likely to increase ecological quality in locations with *H. ranunculoides* and very steep/artificial banks.

In cooperation with waterschap Aa en Maas en waterschap de Dommel

4. **Do feeding-related functional traits predict the invasive success of alien freshwater fishes?**
Leo Nagelkerke
Wageningen University

Successful invasions of alien freshwater fish species are potentially enhanced by efficient food competition with native species. Such competition can be apparent from functional-response experiments, in which generally invaders outperform native species. However, it is mostly unclear which traits drive these differences at the organismal level. Here I will illustrate an ecomorphological approach in which feeding-associated morphological traits of individual fishes will be linked to biomechanical, behavioural, and chemical characteristics of a range of aquatic prey types, leading to quantified feeding capacities of the fish species. I compared alien and native freshwater fish species from the Netherlands (Gobiidae, such as round goby, v. Cottidae, e.g. river bullhead) and South Africa (Centrarchidae, such as smallmouth bass v. native Anabantidae, e.g. Cape kurper), and measured 15-20 feeding-associated morphological traits, covering all stages of feeding, including prey detection, intake, chewing, and digestion. In general, quantified feeding capacities based on morphology were generally in line with actual diets, especially for demanding food types, such as very hard (molluscs) or fast (fish) prey. Alien species were not necessarily direct competitors of native species, but also appeared to be able to fill hitherto 'vacant niches'.

5. **Invasion pathways and public health risks of the raccoon and its roundworm *Baylisascaris procyonis* in the Netherlands**
Miriam Maas, Rea Tatem-Dokter, Jolianne Rijks, Cecile Dam-Deisz, Hester van Bolhuis, Mike Heddergott, Anna Schleimer, Alain Frantz
National Institute for Public Health and the Environment

The geographic range of the zoonotic raccoon roundworm (*Baylisascaris procyonis*) is expanding together with the range of its host, the raccoon (*Procyon lotor*). In the Netherlands, a raccoon population is becoming established and incidental findings of *B. procyonis* have been reported. This creates a new public health risk. To assess this risk, the prevalence of *B. procyonis* was determined in the province of Limburg, where currently the largest Dutch raccoon population is present. Genetic methods were employed to assess invasion pathways of both the raccoon and *B. procyonis* to aid in the development of control measures.
Macroscopic analysis of intestinal content and testing of faecal samples were performed to detect *B. procyonis* adults and eggs. The population genetics of both *B. procyonis* and its raccoon host were analysed using samples from central and northwestern Europe.
B. procyonis was found in 14/23 (61%, 95% C.I. 41-78%) raccoons. Genetic analyses showed that the majority of the Dutch raccoons and their roundworms were introduced through ex-captive individuals.
As long as free-living raccoon populations originate from captivity, population control methods may be pursued. However, natural dispersal from the border regions will complicate prolonged population control, so public education about potential risks is key.

6. **Genetics of invasive feral swine in the US**
Niek Barmentlo, Mirte Bosse, Timothy Smyser, Patrick Meirmans, Bill Stiver, Joe Yarkovic, Blake McCann
Wageningen University

Over the past 30 years, invasive wild pigs (*Sus scrofa*) have rapidly spread throughout the United States, which is surprising as heritage pig breeds were first introduced in the 1500s. Most invasive populations consist of hybrid swarms from Western heritage breeds and European Wild boar. This hybridization is likely to have caused an increased genetic diversity and consequently an increased adaptability to invasiveness. The present research aimed to assess whether these hybrids (feral swine) are genetically diverse and show increased adaptability. To achieve this, we assessed the presence of selection footprints in the genome in an invasive population, and the origin and spread of these selection signals. We found 233 markers under putative selection spread over 79 regions in the GRSM genomes. Two of these regions contained TYRP1 and TYR, which encode for two crucial melanogenesis enzymes. Additionally, genes related to skull formation, neurogenesis and olfaction were found to be under putative selection. The markers under selection from the GRSM appeared to be frequent in secondary introduced populations as well, indicating an important role of these variants. Summarized, this research found a genetic basis for adaptability to increased invasiveness in the invasive wild pigs in the US.

Parallel Session 2

2a: Animals adjusting to a rapidly changing world

Conveners: Bart Nolet (Netherlands Institute of Ecology)
Jan van Gils (Royal Netherlands Institute for Sea Research)

1. **Migratory birds adjusting to a rapidly changing Arctic**
   Bart Nolet, Jan van Gils
   Netherlands Institute of Ecology, Royal Netherlands Institute for Sea Research

Many birds migrate to the Arctic to benefit from the short summer pulse. However, climate in the Arctic is changing more rapidly than anywhere else on the globe. Migratory birds increasingly have to cope with changes in food availability, pathogen and parasite loads and predation pressure. We present examples, mainly from our own research on waterfowl and shorebirds, showing that we already witness resulting changes in migratory bird behaviour, breeding sites, morphology and sex ratio.

2. **Food for thought: dietary expansion facilitates the persistence of a large frugivore in fragmented tropical forest**
   Nacho Villar
   Netherlands Institute of Ecology

It has been suggested that expansion in dietary niche allows populations to persist in human-modified landscapes, yet this hypothesis has been poorly tested in highly diverse ecosystems such as tropical forests where frugivory is ubiquitous. Here, we measured dietary niche expansion of a large frugivorous forest-dwelling mammal in response to forest fragmentation, the white-lipped peccary (*Tayassu pecari*), in the Atlantic Forest, Brazil, by comparing its diet using stable carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) isotopes. White-lipped peccaries fed mainly on forest sources (C_3 resources), especially in continuous forests, but 28% of the individuals in fragmented sites also incorporated C_4 resources to some extent. In fragmented forests, the populations had isotopic niches from 3 to 3.6-fold the size of those in continuous forests. This niche expansion was due to the consumption of food items with higher $\delta^{15}N$ values and C_4 crops. Differences among populations were larger among fragmented forests, suggesting variable site-specific strategies to cope with habitat loss. The mean isotopic values of white-lipped peccary populations were strongly negatively correlated with the loss of forest cover. We suggest that high dietary flexibility and dietary expansion towards consumption of non-forest resources might facilitate the persistence of large mammals like the white white-lipped peccary in fragmented habitats.

3. **Increasing winter temperatures change hibernation site use in the Western barbastelle**
   Luc De Bruyn, Ralf Gyselings, Lucinda Kirkpatrick, Alek Rachwald, Grzegorz Apoznański, Tomasz Kokurewicz
   Research Institute for Nature and Forest

In temperate regions, winter is characterized by cold temperatures and low food availability. Heterothermic animals can bridge this period by decreasing body temperature and reduce metabolic rate (torpor). Hibernation site choice is crucial since temperature conditions in the hibernaculum will impact torpor. We analyzed temperature-dependent hibernation site use of *Barbastella barbastellus*. Bats and temperature were monitored in an underground system (1999-2019) and standalone bunkers (2007-2019) in Western Poland. During the winter of 2017-2018 we analysed the thermal variability of the hibernacula. Seasonal variation is higher in bunkers and thus temperatures get colder in winter than in the underground system. On the other hand, short-term variability (thermal variability index) in the bunkers was lower than in the underground system. This makes bunkers a more stable environment to hibernate for cold dwelling bats in warm winters when temperatures in the bunkers do not get below freezing. During the last decade, a continuous series of warm winters forced more bats to move from the underground system to the bunkers which were too cold in the past. Our study indicates that long-term trends, seasonal variation and short-term variability in temperatures all interact and should be analysed to assess hibernaculum suitability for hibernating animals.

4. Effects of recreation on deer behavior and browsing impact override those of newly established wolves

Bjorn Mols, Joris Comsigt, Dries Kuijper, Chris Smit
University of Groningen

Due to rapid global land use change, large predators are recolonizing human-dominated landscapes. Managing the (perceived) risk created by both carnivores and humans requires novel behavioral adaptations in prey species such as deer. Therefore, we measured the spatial behavior, vigilance and foraging behavior of red deer in a recreational area where a wolf pack recently established. We installed wildlife camera's across a gradient of wolf space use, close to (20 m) and further from (100 m) from hiking trails which are used by both humans and wolves. Additionally we measured recreation intensity and browsing on the vegetation to assess effects of humans and wolves on deer behavior and their browsing impact. Closer to trails, deer visited our plots less and for shorter time compared to further away from trails, yet only during the day. When trails were more intensely used for recreation, visitation frequency was lower, visit duration was shorter, and the proportion of time spent on browsing was lower. Yet we did not measure differences in browsing damage on the vegetation. In contrast, effects of wolf space-use on deer were much weaker and ambiguous. Our study indicates that deer react more strongly and predictably to recreation than to novel wolf presence.

5. Increasing Arctic cloud cover is expected to limit gosling growth and survival

Mo Verhoeven, Bart Nolet, Jan van Gils, Juul Limpens, Theo Elzenga, Emanuele Pallozzi, Angela Augusti, Marion Maturilli, Maarten Loonen
Netherlands Institute of Ecology

Temperature and precipitation in the Arctic are projected to continue increasing with a changing climate. Amplified warming will put migratory birds under pressure to arrive and breed earlier in order to keep up with local phenology, but the consequences of increased precipitation are less clear. On Svalbard, the survival of barnacle goslings (*Branta leucopsis*) is negatively related to precipitation; fewer goslings fledge in wetter summers. The reasons for this relationship are unknown. In wetter years there is less grass for goslings to forage on, but it is unlikely that precipitation limits grass growth in the high Arctic. We hypothesized that it is not rain but rather clouds that diminish gosling survival by limiting the light available for grass growth. We experimentally simulated the effect of cloud cover on grass abundance and quality. Under shaded conditions mimicking wetter years, grass abundance and quality declined below the levels necessary for gosling growth and survival. We used this information to hindcast grass quality for the past 30 years and relate it to gosling growth and survival in those years. We have also started to model how a predicted increase in Arctic cloud cover, resulting from ocean evaporation and sea-ice retreat, will affect goslings.

6. **The extreme migratory adjustment: stop migrating**

Michiel P. Boom, Götz, Eichhorn, Henk P. van der Jeugd & Bart A. Nolet
Netherlands Institute of Ecology

All around the globe animals need to adapt to rapidly changing environmental conditions. Migratory birds generally use several distant locations throughout the year, and are therefore subject to changes in multiple areas. Environmental changes on the breeding grounds, wintering grounds and stop-over locations can have consequences for the fitness of migratory birds. In order to cope with these changes, migratory birds can adjust their timing of migration, breeding location and migratory routes. In extreme cases, the fitness benefits of migration may no longer outweigh the costs, and birds might stop migrating and adopt a resident life history strategy. The barnacle goose has shown such a change in lifestyle. Originally, barnacle geese breed in the Arctic and winter along the North Sea coast. Over the past decades new breeding populations established along the migratory route, and ultimately on the wintering grounds in the temperate region, where the geese have become residents. We compared resident and migratory barnacle geese to study the adaptations that come with such an extreme change in lifestyle. We present the differences we found between migratory and resident barnacle geese, and relate these to the environmental conditions experienced by the geese.

2b: Patterns and processes aiding ecosystem resilience

Conveners: Loreta Cornacchia (Royal Netherlands Institute for Sea Research)
Johan van de Koppel (Royal Netherlands Institute for Sea Research)
Max Rietkerk (Utrecht University)

1. **Pathways of resilience in complex systems**
Max Rietkerk, Robbin Bastiaansen, Swarnendu Banerjee, Johan van de Koppel, Mara Baudena, Arjen Doelman
Utrecht University

The concept of tipping points and critical transitions helps inform our understanding of the catastrophic effects that global change may have on ecosystems, Earth system components, and the whole Earth system. The search for early warning indicators is ongoing, and spatial self-organization has been interpreted as one such signal. Here, we review how spatial self-organization can aid complex systems to evade tipping points and can therefore be a signal of resilience instead. Evading tipping points through various pathways of spatial pattern formation may be relevant for many ecosystems and Earth system components that hitherto have been identified as tipping prone, including for the entire Earth system.

2. **Using deep learning and imagery to identify ecosystem resilience indicators from temporal and spatial patterns of plants and herbivores**
Rebecca James, Jim van Belzen, Prama Wicaksono, Amanda Maishella, Aneesh Chauhan, Freek Daniels, Marjolijn Christianen
Wageningen University & Research

Multiple stressors have led many tropical seagrass meadows to switch from late-successional to dynamic early-successional states exhibiting widescale patchiness. Disentangling the natural seasonal dynamics to those imposed by different stressors is vital for understanding the ecosystem processes related to the patchiness and identifying potential ecosystem resilience indicators. Integrating new deep learning technologies with satellite and drone imagery has enabled us to examine both the spatial and temporal dynamics of remote Indonesian seagrass meadows and build upon an existing mechanistic knowledge of the seagrass ecosystem. Previous experimentation displayed how a substantial turtle population intensively grazing on the seagrass meadow stimulates the meadow patchiness, which becomes further exacerbated by wave action in exposed areas. A dramatic increase in human activity over the last 10 years caused by a tourism-boom, however, has altered these natural dynamics, impeding the grazing areas of turtles and thus impacting the distribution and intensity of the meadow patchiness. By combining a mechanistic understanding with long-term temporal data and deep learning image segmentation, this study highlights the value of examining an ecosystem from multiple spatial and temporal scales to obtain a comprehensive understanding of the ecosystem dynamics and thus, enable the identification of robust ecosystem resilience indicators.

3. **Soil resistance and recovery during Neotropical forest succession**
Masha van der Sande, Jennifer S. Powers, Thom W. Kuyper, Natalia Norden, Beatriz Salgado-Negret, Jarcilene Silva de Almeida, Frans Bongers, Diego Delgado, Daisy H. Dent, Géraldine Derroire, Mario Marcos do Espirito Santo, Juan Manuel Dupuy, Geraldo Wilson Fernandes, Bryan Finegan, Mayra E. Gavito, José Luis Hernández-Stefanoni, Catarina C. Jakovac, Isabel L. Jones, Maria das Dores Magalhães Veloso, Jorge A. Meave, Francisco Mora, Rodrigo Muñoz, Nathalia Pérez-Cárdenas, Daniel Piotto, Esteban Álvarez-Dávila, Yasmani Caceres-Siani, Coralie Dalban-Pilon, Aurélie Dourdain, Dan V. Du, Daniel García Villalobos, Yule Roberta Ferreira Nunes, Arturo Sanchez-Azofeifa, Lourens Poorter
Wageningen University & Research

High resilience of soil conditions is crucial for successful ecosystem restoration. Here, we assess how soils resist forest conversion and agricultural land use, how soils recover during subsequent tropical forest succession on abandoned agricultural fields, and how resistance and recovery depend on climate, soil type, and land-use history. For 21 sites across the Neotropics, we used a chronosequence approach and sampled soils from two depths in old-growth forests, agricultural fields, and secondary forests (1-95 years since abandonment). We measured six soil properties using a standardized sampling design and lab analyses. In this presentation, I will show that soil resilience strongly depends on local conditions. For example, croplands and sites on high fertility show strong increases in bulk density, and decreases in pH, carbon (C) and nitrogen (N) during deforestation and subsequent agricultural use. Furthermore, during forest succession, high-fertility soils and croplands decreased most strongly in bulk density and increased in C and N, possibly because of strongly compacted soils with low C and N after cropland abandonment, and because of rapid vegetation recovery in high-fertility soils leading to greater fine root growth and litter input. Extractable phosphorus (P) did not recover, suggesting increased P limitation as forests age. These results indicate that no single solution exists for effective soil restoration, and that local site conditions should determine restoration strategies.

4. **Butterfly responses to climate change in relation to landscape configuration**
Marjon Hellegers, Chris van Swaay, Arjen van Hinsberg, Mark Huijbregts and Aafke Schipper
PBL Netherlands Environmental Assessment Agency

Understanding and predicting species' responses to ongoing climate change is vital to inform conservation strategies, but this is not straightforward as climate change responses are expected to depend on the landscape context. Our aim was to quantify the effect of climate change on the occurrence and abundance of butterfly species in relation to landscape configuration. We obtained yearly counts of 32 well-monitored butterfly species in the Netherlands from 327 time series over 27 years (1992-2018), corresponding with an increase in mean annual temperature of 0.028 ^{o}C/year. We used these counts to build mixed effect hurdle models to relate species' occurrence and abundance to temperature in the growing season and the amount and connectivity of the (semi-)natural vegetation (SNV) around the sites. For about half of the butterfly species, an increased amount and connectivity of SNV resulted in slightly stronger increases or reduced decreases in distribution in response to warming. In contrast, the response of abundance to warming was not systematically influenced by the amount and connectivity of SNV. Our results suggest that increasing the amount and connectivity of SNV may increase colonization rates and metapopulation persistence of butterfly species during warming, but does not offer a 'one-size-fits-all' solution.

5. **Can we infer dryland restoration success from remotely sensed vegetation patterns?**
Yanning Qiu, Zhiwei Xu, Chi Xu, Milena Holmgren
Wageningen University & Research

Vegetation spatial patterns are commonly applied as indicators for monitoring and anticipating dryland degradation, but their potential for signaling ecosystem recovery has only been approached theoretically and never been validated in field restoration projects. Here we explore if vegetation spatial patterns can be used to monitor ecosystem recovery and anticipate the success of restoration practices. We combined field surveys and high-resolution digital images to assess how vegetation spatial patterns change after a large-scale active restoration project in Tengger Desert, China, and discuss the implications of vegetation pattern as recovery indicators.

We found rapid increases in vegetation cover coupled to characteristic vegetation pattern changes that are generally associated with shifts in ecosystem condition, such as an increasing proportion of large-size patches as restoration advanced. Combining spatial patterns with an analysis of the changes in plant species composition improves the assessment of dryland recovery trajectories, despite the artificial planting schemes and community succession may also compromise the consistency of these indicators. Our work demonstrates that vegetation patterns obtained from high-resolution remotely sensed images provide useful information for monitoring ecological restoration trajectories.

6. **How to rebuild climate-resilient wetlands: tidal channel development in natural and constructed salt marshes**
Loreta Cornacchia, Roeland van de Vijsel, Daphne van der Wal, Quan-Xing Liu, Tom Ysebaert, Johan van de Koppel
Royal Netherlands Institute for Sea Research

Salt marshes are coastal ecosystems that lie at the forefront of sea-level rise and must rapidly adapt to it. The presence of spatial patterns could help in ecosystem adaptation: naturally patterned, self-organized ecosystems are more resilient than ones without patterns. Although humans have been rebuilding coastal ecosystems to adapt to climate change, their development is often not going as planned. Thus, it is unclear whether we have been successful in building climate-resilient marshes.
In a combined remote sensing and modelling study, we explore the effect of restoration approaches (artificial creek excavation vs. self-developing creek patterns) on the further development of creeks in salt marshes, to understand how that impacts the ability of these ecosystems to become climate-resilient (i.e., to efficiently transport sediment through the creek system to keep up with sea-level rise).
We found that restored saltmarshes have significantly lower creek development and less efficient channel networks than natural systems. Creeks in restored sites are out of balance with the local hydrodynamics: their cross-sections are oversized compared to the watershed area and tidal prism. Finally, restored marshes are less resilient than their natural counterparts: model simulations showed that self-organized creeks have higher sediment transport efficiency than the excavated creeks. Our findings suggest the need to carefully design restored ecosystems and optimize channel design to follow natural, self-organized patterns to improve their resilience.

2c: Modelling ecology

Conveners: Monique de Jager (Netherlands Institute of Ecology)
George van Voorn (Wageningen University & Research)

1. **Impact of chemical contamination on aquatic regime shifts: a model based study**
Swarnendu Banerjee, Bapi Saha, Max Rietkerk, Mara Baudena, Joydev Chattopadhyay.
Utrecht University

Ecological modelling is an important tool to understand and predict the impact of anthropogenic changes on the environment. In the case of aquatic systems, abrupt transitions leading to algal blooms are quite well known and have important implications for the environment. Contamination with heavy metals such as copper can modulate ecological interactions which in turn may impact such regime shifts. With the help of a mathematical model, we explored the effect of copper enrichment on regime shifts in planktonic systems. We integrated copper contamination to a minimal phytoplankton–zooplankton model which is known to demonstrate abrupt transitions between ecosystem states. Our results suggest that both the toxic and deficient concentration of copper in water bodies can lead to regime shift to an algal-dominated alternative stable state. Further, interaction with fish density can also lead to collapse of population cycles thus leading to algal domination in the intermediate copper ranges. Environmental stochasticity may result in state transition much prior to the tipping point. Finally, the impending state shifts due to contamination cannot be predicted by the generic early warning indicators unless the transition is close enough.

2. **Lake Valkenburg: How interdisciplinary modelling efforts assist real world decision making**
Lilith Kramer, Gerard van der Schrier, Franca Kramer, Wolf Mooij, Sven Teurlincx.
Netherlands Institute of Ecology

Lake ecosystems worldwide are under threat from a large range of regional stressors. On top of that, the world's climate is changing rapidly, which impacts these ecosystems in varying ways. Understanding these impacts is vital, as humans rely heavily on the ecosystem services lakes provide. By combining different models (e.g. climatic, physical, or ecological) in novel ways, we can gain insight into future lake ecosystem functioning and quantify the uncertainty in possible outcomes. Here, we present the case study of Lake Valkenburg. In this case study we quantify the ecological impacts of changing management through a combination of a physical lake model (FLake) and an ecological model (PCLake+). More specifically, we look at the impact of future water abstraction for drinking water production on the ecological state of the lake. When feeding this combination of models varying climate ensemble model runs (KNMI'14 climate scenarios, RACMO model), we are able to incorporate the impact and uncertainty of a changing climate. Through this, we aim to support management and policy decisions for the ecological maintenance of Lake Valkenburg in the future. More broadly, we gain scientific understanding of ecosystem functioning and resilience in a changing world.

3. **Periphyton shading dynamics determines success of submerged macrophytes in temperate shallow lakes**
Alena Gsell, Sven Teurlincx, Marta Alirangues Nuñez, Sabine Hilt.
Netherlands Institute of Ecology

Periphyton shading is supposed to play a key role in macrophyte decline during eutrophication, but data on the effect of timing and amount of periphyton shading on macrophyte persistence are scarce. Here, we added periphyton shading to the ecosystem model PCLake+ to assess the effects of timing and amount of periphyton shading, as well as timing and duration of interim reduction in periphyton shading in spring (e.g. by grazing) on the persistence of macrophytes in a generic lake. Our modified model captured well how gradual changes in periphyton shading can drive a regime shift towards loss or return of macrophytes. The threshold values and hysteresis space depended on the phosphorus loading and the timing of the periphyton shading development. In phosphorus loading and timing of periphyton shading scenarios that result in loss of macrophytes, the introduction of a periphyton grazing period can maintain macrophytes. Generally, earlier and longer grazing periods relative to the growing phase of macrophytes were more beneficial for macrophyte persistence. Our results will help to better understand the role of periphyton in macrophyte biomass development and improve PCLake+ as a tool for lake restoration in shallow lakes.

4. Estimation of collision mortality of the lesser black backed gull with an individual based model

Floor Soudijn, Rob van Bemmelen, Daniel Benden, Abel Gyimesi.
Wageningen Marine Research

The lesser black backed gull is considered sensitive to collisions with offshore wind turbines. Current estimations of collision mortality are uncertain due to uncertainties in the intensity of bird movements at sea. We developed an individual based model (IBM) of lesser black backed gulls using GPS-track data of gulls in the colonies "Texel", "Neeltje Jans", "Vlissingen", "Oostende" and "Zeebrugge" along the Dutch coast. GPS-track data of breeding individuals was analysed with a Hidden Markov Model (HMM) to derive typical behavioural states and step sizes and turning angles of the birds. The HMM was used as a basis for the IBM and environmental variables such as distances to fishing vessels, to the colonies and the coast were incorporated to mimic gull behaviour. Colony specific initial directions of trips were incorporated in the IBM to allow for location specific directionality in bird trips. The IBM simulations reproduced spatial distributions and trip durations of the gulls relatively well. However, the IBM predicted unrealistically high collision mortality probabilities of ~2-15% per year. There are several gaps in our knowledge of lesser black backed gull behaviour around offshore wind farms that need to be filled to allow reliable estimates of collision mortalities for this species.

5. Interspecific dependences in macrozoobenthos abundance in the Wadden Sea

Mark Rademaker
Royal Netherlands Institute for Sea Research

Macrozoobenthos form a crucial component of the Wadden Sea ecosystem by recycling nutrients, decomposing organic matter, and by functioning as a food source for other organisms. Although the abiotic preferences of macrozoobenthos have been well researched, much less is known about the interdependencies between different macrozoobenthos species, and how these might be mediated by the environment. We developed a deep learning model to identify how biotic and abiotic interactions simultaneously affect the occurrences of macrozoobenthos in the Wadden Sea ecosystem. The model was trained on a large systematic survey dataset of macrozoobenthos in the Dutch Wadden Sea. We find that macrozoobenthos populations in the Dutch wadden sea can be divided into 3 distinct abiotic communities. Furthermore, the model found a gradient of strong positive to negative relationships between the occurrences of each species and the abundance levels of other species in the dataset. However, we also find that a high level of expert taxonomic and system's knowledge is essential to interpret these findings ecologically. We conclude that our modelling approach represents a useful exploration tool to highlight complex interdependencies in large and high-dimensional ecological datasets, but must be used in combination with expert knowledge to derive inferences on possible mechanisms.

6. Survival modelling as part of an Adaptive Flyway Management Programme for the barnacle goose

Lisenka de Vries
Netherlands Institute of Ecology

Adaptive management is a valuable tool in the management of ecosystems or populations to prevent decreases or strong increases in population numbers. Adaptive management is a structured, iterative way of making management decisions, in which the amount of uncertainty is gradually decreased by constant evaluation of the system, and taking the needs of various stakeholders into account. Here we illustrate this process by means of the Adaptive Flyway Management Programme specified in the International Single Species Management Plan for the barnacle goose, developed under the Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA).
As part of this AFMP, a population-specific survival model was developed for the Russia/Germany & Netherlands flyway population of barnacle geese, using long-term mark-recapture data. Insight will be given into the choice and further implementation of the final survival model. Determining factor in this is not only the required results, but also the possibilities given the long-term mark-recapture dataset that was used and the dynamic population structure of the Russia/Germany & Netherlands flyway population of the barnacle goose, which includes migratory as well as resident birds.

2d: Viral Ecology

Conveners: Kyle Mason-Jones (Netherlands Institute of Ecology)
Marcelle Johnson (Netherlands Institute of Ecology / Wageningen University and Research)

1. Highly pathogenic avian influenza in wild birds in Europe

Ron Fouchier
Erasmus University Medical Center

Wild birds of the orders Anseriformes (ducks, geese, swans) and Charadriiformes (gulls, terns, waders) are the natural hosts for low pathogenic avian influenza (LPAI) viruses. Migratory birds may carry such viruses without clinical consequences. Unfortunately, over the last decades, wild birds have also become victims of highly pathogenic avian influenza (HPAI) viruses. The A/Goose/Guangdong/1/96 (GsGd) lineage of HPAI H5 virus first emerged in poultry in Southeast Asia more than 25 years ago. From 2005 onwards, the viruses started spreading from Asia to Russia, western Europe, Africa and the Middle East, causing high mortality in wild birds and poultry. This spread was a result of the unprecedented long-distance transport of HPAI viruses, in which wild migratory ducks, geese and swans were implicated. Since 2014/2015, the viruses are expanding both in geographical spread and host range and have caused ever larger outbreaks in wild birds and poultry in Europe nearly every year. Thus, this lineage of HPAI H5 virus is an increasing threat to the health of wildlife, poultry and mammals, including humans worldwide. It is also a growing economic problem for the global poultry sector, affecting food security in some countries. I will give an overview of current studies on HPAI virus in relation to wild birds in Europe.

2. Virophages and retrotransposons colonize the genomes of aquatic flagellates

Thomas Hackl, Sarah Duponchel, Anna Koslova and Matthias G Fischer
University of Groningen / Max Planck Institute for Medical Research

Virophages can parasitize giant DNA viruses and may provide adaptive anti-giant virus defense in unicellular eukaryotes. Under laboratory conditions, the virophage mavirus integrates into the nuclear genome of the marine flagellate *Cafeteria burkhardae* and reactivates upon superinfection with the giant virus CroV. In natural systems, however, the prevalence and diversity of host-virophage associations has not been systematically explored. Here, we report dozens of integrated provirophages in bicosoecid flagelates from marine and fresh-water environments, includuing 8 types of mavirus-like virophages in four globally sampled *C. burkhardae* strains. The latter account for up to 2% of their hosts' genomes and based on promoter motifs likely interact with different giant viruses. Between hosts, some provirophage loci were conserved indicating ancient integration events, whereas the majority of insertion sites were unique to a given host suggesting that these viruses are active and mobile. Furthermore, we uncovered a unique association between virophages and a group of tyrosine recombinase retrotransposons, revealing yet another layer of parasitism in this nested microbial system. Our findings show that virophages are widespread and dynamic in wild bicoecid populations, supporting their potential role in antiviral defense in protists.

3. Antarctic Viruses: seasonal diversity and dynamics

Goncalo Piedade, Tristan Biggs, Henk Bolhuis, Bas Dutilh and Corina Brussaard
Royal Netherlands Institute for Sea Research

Polar regions are undergoing global warming induced changes that are expected to result in profound alterations in productivity and microbial community composition. The ecology and evolution of viruses are entwined with that of their hosts, making them key modulators of microbial populations. To date, only a few studies targeted viral diversity in Antarctic waters, let alone on a temporal scale. Here we present the results of a time-resolved metagenomics survey targeting the DNA virus community composition (and their potential microbial host community) in the coastal waters of Western Antarctic Peninsula for 2 subsequent productive seasons. We examined the dynamics of viruses predicted to infect key heterotrophic bacteria. For example, we track viruses predicted to infect members of the orders Oceanospirillales and Flavobacteriales, which were some of the most abundant bacterial taxa, which highlight the potential role of viruses in promoting succession. Temperature and salinity best explain the change in viral community composition (35% of the observed temporal change). Our study highlights the importance of studying these viral communities and their impact in microbial communities in face of climate change.

4. **Both the enzymatic- and structural properties of Autographa californica multiple nucleopolyhedrovirus (AcMNPV) protein tyrosine phosphatase (PTP) are insignificant for brain entry in *Spodoptera exigua* caterpillars**
Simone Gasque, Dorothy van Leeuwen, Monique van Oers and Vera Ros
Wageningen University and Research

Parasitic alteration of host behaviour can be caused by a broad range of organisms. Only for a few of these parasites it is known that they manifest and alter these behavioural-changes from the central nervous system (CNS) itself, and little is known about the mechanisms behind these alterations. Neuroparasitology intertwines the existing fields of neurology, biology and parasitology – covering the cases of parasitic manipulation of the CNS. After infection by baculoviruses, infected caterpillars climb the vegetation in "tree-top"-disease, and/or express hyperactivity. Baculoviral infections result in liquefaction of the caterpillars and release of virus progeny. Both behavioural alterations are thought to increase the chance of transmission to susceptible hosts. Previous studies have shown that for a subset of baculoviruses the viral protein tyrosine phosphatase (PTP) is required to induce hyperactivity. Here, we studied baculoviral entry into the CNS of 3rd and 4th instar *Spodoptera exigua* caterpillars using fluorescently tagged Autographa californica multiple nucleopolyhedrovirus (AcMNPV). Using different viral constructs (with PTP, without PTP or with a catalytically inactive PTP) we show that the enzymatic function of PTP is not mandatory for CNS-entry, neither is the presence of PTP as such. Furthermore, we will elaborate on the observed patterns of localization of the different virus-constructs within the CNS.

5. **Effects of body condition and urbanisation on innate immunity in Common blackbirds *Turdus merula***
Jurrian van Irsel, Fred de Boer, Ruud Foppen, Henk van der Jeugd, Tjomme van Mastrigt, Elise Schuurman, Kevin Matson
Netherlands Institute of Ecology

The study is focused on mosquito-borne Usutu virus and its impact on the bird populations, where we use the Common Blackbird population as a case study. The Common blackbirds showed high mortality rates following the Usutu virus outbreak, particularly in urban habitats. Urban habitats have extremely high blackbird densities with in some cases almost a ten-fold higher population density compared to forest habitats. These high densities also compete for feeding sources, which may particularly have effects during the breeding season, when the chicks require high quality food for growth and development. Furthermore, the available food may be of lesser quality due to higher concentrations of harming sustances such as heavy metals, or lower weight per food item. These limiting feeding sources may impact the growth and development of the chicks leading to energy trade-offs between energetically demanding processes. As the general pathogen circulation is assumed to be lower with urbanistation, chicks in highly urbanised habitats may be more likely to invest less in immune development. To study whether the immune status differs in blackbirds chicks with urbanisation, we started in 2021 with an extensive nest study on Blackbird populations with the gradient of Urbanization and measured the nestlings and took a blood sample for Usutu virus infection detection and immunological assays. We now focused on Haptoglobin- and Nitric oxide concentration and lysis and agglutination.

6. **Costs and benefits of non-selective packaging of viral genome segments into virus particles**
Mark Zwart, Marcelle Johnson, Erick Bermúdez-Méndez & Paul Wichgers Schreu
Netherlands Institute of Ecology

Viruses are obligate intra-cellular micro-parasites, and integral parts of ecosystems. One of the main challenges viruses must overcome is to spread within and between host organisms. Segmented viruses have two or more genome segments. Many of these viruses package their genome segments into virus particles selectively, ensuring that each virus particle contains a complete genome and is capable of transmission. Some segmented viruses such as the tri-segmented Rift Valley fever virus (RVFV) package their genome segments non-selectively, resulting in a complex distribution of genome segments over virus particles. Here we ask whether this genome packaging strategy is costly, and whether there are any benefits associated with it. We developed a simple model of infection that shows that this strategy comes at a high cost to between-host transmission, although the possibility for complementation between incomplete particles lowers the cost for within-host spread. Recent empirical work on segmented and multipartite viruses further suggests that changes in the frequency of viral genome segments can be adaptive. We developed a simulation of a bi-segmented virus, allowing us to study competition between identical viruses employing different genome packaging strategies. These simulations show that a non-selective packager can outcompete a selective packager under a wide range of conditions. The capacity to adjust the frequency of genome segments and viral gene expression is a putative beneficial trait associated with non-selective genome packaging that may explain why this virus particle organization has evolved.

Parallel Session 3

3a: Driving forces: Behavioural responses to anthropogenic change

Conveners: Marion Nicolaus (Groningen Institute for Evolutionary Life Sciences)
Janne Ouwehand (Groningen Institute for Evolutionary Life Sciences)

1. **The role of genes and early-life environment in shaping migration routes of Eurasian Spoonbills**
Tamar Lok, Jocelyn Champagnon
Royal Netherlands Institute for Sea Research

Seasonal migration is a fascinating phenomenon that enables animals to exploit seasonal peaks of resource abundance. To do so, they have to make the right decisions when to migrate and where to. Changes in any of the sites that migratory animals use during their annual cycle may affect the optimality of these decisions. To understand the limits to the capacity of migratory animals to respond to environmental change, we need to understand the mechanisms that lead to their migratory decisions. Here, we address the importance of genetic and environmental factors in shaping the first southward migration of Eurasian Spoonbills *Platalea leucorodia.* To this aim, we performed a large-scale common-garden experiment in which we exchanged eggs of spoonbills between two populations exhibiting contrasting migration routes (The Netherlands versus southern France) and equipped the juveniles raised from these eggs with state-of-the-art tracking devices to monitor their migration routes. In this talk, I will present the results from this experiment.

2. **Home-range behaviour of Pied Flycatchers (*Ficedula hypoleuca*) in relation to small-scale vegetation green-up within a West-African non-breeding site**
Wender Bil, Armel Asso, Pam van Eekelen, Bram Oosterbeek, Raymond Klaasen, Christiaan Both, Janne Ouwehand
Groningen Institute for Evolutionary Life Sciences

Presentation abstract. Flexibility in small-scale spatial behaviour may aid the resilience of birds to environmental change by holding off the need for potentially costly behavioural responses like large-scale dispersal. Such flexible abilities might be especially advantageous for migratory species, that are often faithful to multiple individual staging sites throughout their annual routines. However, generally little is known about the small-scale spatial behaviour of these species and to which extent it might aid a response to natural or anthropogenic environmental change, which is especially true for the non-breeding period. In this study we try to address this knowledge gap by investigating the dynamics in ecological conditions and its effect on the spatial behaviour within the context of the non-breeding environment of a migratory insectivorous songbird: the Pied Flycatcher (*Ficedula hypoleuca*). By combining novel techniques like UAV-based remote-sensing and automated animal tracking, we are able to investigate fine-grained spatiotemporal relationships between primary production (NDVI) and arthropod availability and its ultimate effect on individual home-range size and body condition. We discuss the results of our small-scale approach within the framework of the ongoing use of satellite based remote-sensing techniques in studies that address the links between environmental conditions and behaviour of avian migrants.

3. **Human-induced isolation causes rapid behavioral divergence with genetic underpinnings in resident and migrant sticklebacks**
Aparajitha Ramesh, Mariana Domingues, Eize Stamhuis, Ton Groothuis, Franjo Weissing, Marion Nicolaus
Groningen Institute for Evolutionary Life Sciences

The adaptive capacity of many organisms is seriously challenged by human-induced environmental change. Water management measures in the 1970s in the Netherlands have produced a large number of land-locked 'resident' populations of three-spined sticklebacks (*Gasterosteus aculeatus*), which are cut-off from the originally 'migrant' populations. Here, we made use of this unintended field-experiment, to study the impact of human-induced isolation on behavior and morphology. We detected differences between migrant and resident populations in virtually all phenotypic traits studied: compared to the migrants, residents were smaller in size and were significantly more active, aggressive, exploratory and bolder and showed lower shoaling and migratory tendencies. Furthermore, to investigate if these differences in wild-caught residents and migrants reflect genetic differentiation, rather than different developmental conditions, we performed a 'common-garden experiment'. We raised offspring of four crosses (migrant ♂ x migrant ♀, resident ♂ x resident ♀, migrant ♂ x resident ♀, resident ♂ x migrant ♀) under similar controlled conditions and tested for differences in phenotype as adults. We found that lab-raised resident sticklebacks exhibited lower shoaling and migratory tendencies as compared to lab-raised migrants, retaining the differences in their wild-caught parents. This indicates genetic differentiation of these traits. For all other traits, the lab-raised sticklebacks of

the various crosses did not differ significantly, suggesting that the earlier-found contrast between wild-caught fish reflects differences in their environment. Our study shows that barriers to migration can lead to rapid behavioral divergence over contemporary timescales (~50 generations), and that part of these differences reflects genetic differentiation.

4. **Both genetic and plastic effects underlie phenotypic differences between rural and urban great tit (*Parus major*) populations**
Barbara Tomotani, Anne Charmantier, Szymon Drobniak, Marcel Eens, Carys Jones, Erik Matthysen, Ben Sheldon, Marcel Visser, Kees van Oers
Netherlands Institute of Ecology\

The process of urbanization causes drastic changes in the environment, putting organisms living in cities under contrastingly distinct selective pressures when compared to forests. Urban environments are warmer, noisier, illuminated at night, and with marked differences in predation pressure and the abundance and quality of available food. Birds living in cities are shown to be different from those in forests, being bolder, more exploratory and showing physiological and behavioural phenotypes associated with a faster pace-of-life. One outstanding question, however, is whether such differences are plastic responses due to living in the cities, or whether they are inherent characteristics of the individuals. Here we will show the first results of a common garden study aimed at answering this question. We collected great tit eggs from six cities and eight forests (across five different countries) and hatched and raised the chicks in a common environment. We measured fledgling age, exploratory behaviour and boldness in standardized conditions. Our preliminary results show both genetic and plastic effects shedding new light on the origin of personality and fledging age differences between rural and urban populations.

5. **The effects of Artificial Light At Night on plant-insect interactions**
Robin Heinen, Oriana Sanchez, Sarah Sturm, Zoë Pfeiffer, Martijn Bezemer, Johannes Kollmann, Michael Schloter, Jörg-Peter Schnitzler, Corina Vlot, Wolfgang Weisser
Technical University of Munich

Artificial Light At Night (ALAN) is increasingly present in terrestrial ecosystems worldwide. Although many studies show that light pollution has direct devastating consequences for animal physiology, behavior and fitness, surprisingly little is known about the effects of ALAN on plants and the associated phytobiome. Reductions in ALAN are commonly suggested as potential solutions to mitigate ecological effects, but the effects of such an approach have not been studied. In a climate chamber facility, we exposed plants to fully lit, fully dark nights, or an intermediate, where only the first half of the night was lit, and then introduced aphids to the plants. We found that ALAN had mildly positive effects on plant growth, but consistently suppressed aphid colony formation over time. Surprisingly, the suppressive effects of ALAN were strongest under intermediate ALAN treatment, suggesting that the effect of ALAN mitigation may stress aphids more than ALAN itself. We quantified defense gene expression in the plants, to show that ALAN suppressed defenses, but strongly correlated with aphid numbers, suggesting that the effects of ALAN on plant-aphid interactions are behavioral, rather than plant defense-mediated. ALAN affects plants and insects in complex ways, and mitigation will be more complex than flipping the switch.

6. **Using microphone arrays and LiDAR to study the response of bats to artificial light in forest edge habitat**
Claire Hermans, Jens Koblitz, Harm Bartholomeus, Marcel Visser, Kamiel Spoelstra
Netherlands Institute of Ecology

Urbanization is a major threat for biodiversity due to various sources of pollution, including artificial light at night. The growth of lit outdoor areas is likely to affect nocturnal ecological communities. Bats are particularly vulnerable to light pollution since they are almost exclusively nocturnal and strongly react to light. Previous studies showed that bat activity varies with light spectrum, with less activity disturbance by red light. However, our knowledge on how bats alter their behavior in response to different artificial light intensities, and how this interacts with vegetation, is limited. We investigated these effects on bats foraging in forest edge habitat at replicated, long-term experimentally illuminated transects. We used microphone arrays to record bat foraging activity throughout the night and reconstruct flight patterns of bats. The vegetation structure was assessed by Light Detection and Ranging (LiDAR). We hypothesized that bats fly closer to vegetation when exposed to higher light intensity levels to reduce risks of predation. We further investigate the compromise between predation risk and feeding success by examining the spatial distribution of feeding attempts around the light in bats with different foraging strategies.

3b: Soil ecology in a changing world

Conveners: Emilia Hannula (Leiden University)
Elly Morriën (University of Amsterdam)
Ciska Veen (Netherlands Institute of Ecology)

1. Watching the soil with Artificial Intelligence: Earthworm and springtail interactions during drought

Anne Krediet, Bob Mönnichs, Matty P. Berg
Vrije Universiteit Amsterdam

Earthworms by their burrowing activity strongly change soil conditions. This makes earthworms the most important ecosystem engineers in soil. Their presence creates habitat for non-digging species, such as Collembola (springtails). Especially during dry periods, springtails migrate through soil pores to deeper, moister layers. Thus, earthworms may alleviate the effects of climate change for springtails. However, this has never been investigated.
With an innovative method, we investigated how the burrowing activity of two dominant earthworm species (*Aporrectodea longa* and *A. caliginosa*) affected the survival and vertical distribution of the springtail *Folsomia candida* under drought stress. We held earthworms in narrow transparent cuvettes and used Artificial intelligence to map the earthworm burrows from photos. We also measured springtail depth and survival.
We observed that the two earthworm species responded differently to the drought treatment. *Aporrectodea longa* reduced its burrowing activity, while *A. caliginosa* moved to deeper soil layers. It was evident that *F. candida* did use the burrows to migrate to deeper soil layers. However, the effect of drought on migration of *F. candida* was less clear. These results suggest that climate change may change earthworm activity which in turn affects other soil fauna.

2. Earthworms as invasive species in boreal forests

Justine Lejoly, Sylvie Quideau, Jérôme Laganière
University of Alberta

The last glaciation wiped out most native earthworms from North America. Exotic earthworms have been invading temperate forests since European settlement and, a result of anthropogenic activities and global warming, are now able to spread into boreal forests. Although earthworms are seen as beneficial for agriculture, their presence might not be desirable in forests that have developed in their absence.
While most research on the topic focussed on temperate forests, fewer studies were conducted in boreal forests, which represent the largest terrestrial carbon (C) reservoir. To study the impacts of earthworms on SOM dynamics, we selected sites across the most common soil types found in the Canadian boreal forest. Earthworm presence led to decreased C stocks in the organic layer and the development of re-worked surface mineral horizons, with higher total and labile C content.
In the mineral soil, earthworms notably favoured fungi over bacteria, mainly by an increased relative abundance of ectomycorrhizal fungi. Shifts in bacterial communities suggest higher nutrient availability and faster nutrient cycling, corroborated by an increase in microbially-degraded SOM and higher C oxidation state. Invasive earthworms greatly affect SOM dynamics in boreal forests and might therefore alter C sequestration, forest productivity, and ecosystem services.

3. Self-organization of microbial communities and their functioning is influenced by crop rotational diversity

Lilia Serrano Grijalva, Raúl Ochoa-Hueso, Ciska Veen, Lisa Tiemann, Marshall McDaniel, Stuart Grandy, Wim van der Putten
Netherlands Institute of Ecology

Intensive management practices have altered the balance between the fertility, structure, and biodiversity of soils in agroecosystems. Sustainable agricultural practices, such as increased crop rotations and crop diversification are used to restore ecological processes. Here, we evaluate the role of increasing crop rotational diversity (monocultures up to 5 rotations) in determining the spatially self-organized patterns of soil microbial communities within the micro, macro and mega-aggregates where they inhabit. We used the concept of coupling to characterize the degree of spatial structuring of communities of soil biota. Soil communities within aggregates were strongly coupled in nine out of eighteen instances. Opposite to our expectations, we found a negative relationship between the degree of soil microbial coupling and crop rotational diversity. This result was mostly driven by the relationship between coupling and rotational diversity in micro and macro-aggregates. However, there was not such a relationship in mega-aggregates. Arbuscular mycorrhizal fungi were most abundant in monocultures and appeared to play a major role in determining the coupling pattern of soil communities. Our work suggests that increasing the number of crop species in rotations holds back the natural tendency of soil communities to become spatially self-organized, allowing a more functional configuration of soils.

4. The interplay between soil nutrients, mycorrhizal fungi and the common juniper

Rik Veldhuis, Kris Verheyen, Fons Smolders, James Skinkis, Chris Smit
University of Groningen

Nitrogen deposition is affecting soil ecology worldwide by causing nutrient leaching and acidification. These biochemical changes can affect the soil microbial community, including mycorrhizal fungi, and subsequently the performance of plants. One of the plants that seems to suffer from high nitrogen deposition loads is the common juniper (*Juniperus communis*), which populations are declining due to a lack of rejuvenation. Using multiple field experiments we investigated the interactions between soil acidification, mycorrhizal fungi and junipers. We showed that by altering soil nutrient concentrations, N deposition 1) reduces positive effects of mycorrhiza on junipers, 2) reduces mycorrhizal fungi diversity in junipers' rhizosphere, 3) deteriorate nutrient balance of leaves which are associated with plant growth and seed production. Restoration measures such as addition of lime + rock powder can restore soil pH and nutrient concentrations and thereby improve nutrient balance of juniper leaves and juniper rejuvenation as well. Besides these measures, it is crucial to reduce ongoing nitrogen pollution and safeguard juniper populations in north-western Europe.

5. The effect of salinization on natural floating fen biogeochemistry and plant community

Milou Huizinga, Gijs van Dijk, Richard van Logtestijn, Rien Aerts, Jan-Philip Witte, Oscar Franken
Vrije Universiteit Amsterdam

Salinization of surface water is a large problem worldwide. Due to natural and anthropogenic processes the salt concentration of surface water has risen and this problem is predicted to increase in the future. In deltaic areas – such as The Netherlands – sea water is flowing further inland via rivers during summer. In addition to this, land subsidence has led to a self-enforcing hydrological cycle: an increasing need for drainage of low-lying agricultural polders which leads to an increasing need to compensate for the water loss from higher elevation surface water dependent ecosystems and subsequently to more land subsidence. Both processes lead to salinization of fresh water and surpassing of the current Dutch 200mg $Cl.L^{-1}$ fresh water threshold. Important to notice is the very low threshold value, which emphasizes that salinization does not always lead to sea water concentrations but more often leads to a spectrum of suboptimal water qualities. This salinizing water can reach surface water dependent natural ecosystems and cause root zone salinization. While often studied in an agricultural context, almost nothing is known about the effects of slight to moderate salinization and how it might affect ecosystem processes and biodiversity in natural ecosystems. As a case study we present a comparison between 'De Botshol' and 'Nieuwkoopse Plassen' in The Netherlands. These floating fen habitats harbour numerous protected plant species with – ideally – along the water's edge the highest plant biodiversity. In addition to this, peat formation in these systems is pivotal for nutrient cycling and carbon storage. The surface water quality of 'De Botshol' is brackish (and is predicted to become more brackish) while 'Nieuwkoopse Plassen' is fresh (but also predicted to receive more salt input in the future) and this provided us with an opportunity to take a first look at the spatial (i.e. along a horizontal transect and vertical gradient from the root mat edge until 2m from the edge) and temporal (i.e. throughout a year) route of salinization and its effects on soil biogeochemistry and the plant community. By linking hydrology, to biogeochemistry, to ecology and also to expectations based on, for instance Ellenberg values for salt tolerance or critical salt values from laboratory studies, we hope to get a better understanding of the effect of salinization. Next to that our aim is to inform water boards and nature managers to what extent low concentration surface water salinization might affect their floating and transition mire restoration and protection goals.

6. 10 years soil nutrient chemistry of a rewetted and managed peatland: implications for wet peatland use

Ralph Temmink, Renske Vroom, Gijs van Dijk, Sannimari A. Käärmelahti, Adam H.W. Koks, Hans Joosten, Matthias Krebs, Greta Gaudig, Leon Lamers, Alfons Smolders, Christian Fritz
Utrecht University

Storing 1250-2000 Mg C/ha, peat is the earth's densest carbon-storing soil type. Drainage has converted more than 10% of these long-term carbon sinks to strong carbon sources. In parallel, this land-use change has led to biodiversity loss, land subsidence and water quality problems. A land-use alternative that allows rewetting of drained peatlands, while maintaining agricultural production is the cultivation of *Sphagnum* biomass as a renewable alternative for fossil peat in horticultural growing media (*Sphagnum* paludiculture). We studied soil nutrient dynamics and *Sphagnum* productivity in a 14-ha site in Germany, where topsoil was removed and that was rewetted 10 years ago. The site is irrigated with nutrient-rich water and atmospheric nitrogen deposition is high (20 kg/ha/yr). Our data show that 10 years post rewetting, despite high nutrient loads, no nutrients have accumulated in the porewater of the new organic layer. Furthermore, porewater ammonium concentrations decreased from 400-700 to 0-50 µmol/L in the old soil profile across 100 cm over 10 years. In contrast, the new grown 25 cm thick organic layer has stored high amounts of nutrients in its biomass. We conclude that wet peatland use, despite high nutrient inputs, may contribute effectively to tackling downstream eutrophication.

3c: Biogeography and macroecology in the Anthropocene and Quaternary II

Conveners: Sietze Norder (Leiden University)
Kenneth Rijsdijk (University of Amsterdam)
Majoi de Novaes Nascimento (University of Amsterdam)

1. Variability of past human legacies in north-western Amazonian forest plots

Britte Heijink, Quinten Mattijs, Crystal McMichael
University of Amsterdam

Forest plots are vital in understanding Amazonian biodiversity, carbon dynamics, and species composition. Past humans have impacted vegetation composition for thousands of years in Amazonian rainforests and might have left ecological legacies. We explore these potential ecological legacies at one of the most biodiverse and heavily studied places on Earth, the Yasuní Forest Dynamics Plot in Ecuador. Yasuní is an old-growth, undisturbed forest. We reconstruct past vegetation history by analyzing phytoliths (silica-based microfossils) that can detect past agriculture, canopy openings, and changes in palm composition. We used charcoal to reconstruct past fire occurrences and radiocarbon-dated any fragments to get an age on past fire events. Yasuní showed no evidence of past agriculture, large-scale fire events, or wide-spread canopy openings. Yasuní displays evidence of localized and intermittent canopy openings, which may be the result past peoples. Yasuní contains ecological legacies heterogeneously distributed across the plot. We compared our results to Amacayacu, a forest plot in Colombia, where no legacies are present. The difference between forest plots in ecological legacies indicates that past human impact on forest composition is not homogenous across Amazonian rainforests. Understanding and mapping ecological legacies is crucial for understanding carbon dynamics and mitigating the effects of climate change.

2. Exploring the trade-off between productivity and animal diversity in European forests

Calyne Khamila, Thomas Groen, Bert Toxopeus, Luca Santini, Mathias Neumann, Chris van Swaay, Henk Sierdsema
University of Twente

The potential link between productivity and biodiversity can cause tensions in whether forest management should focus on productivity or biodiversity conservation. A spatial quantification of the overlap between diversity and productivity can inform strategic planning of forest management by outlining which areas are suitable for either conservation, production or both. We explored the relationship between net primary productivity and biodiversity of mammals, birds, reptiles, amphibians, and butterflies in the EU and mapped their overlap. We created richness maps by stacking species distribution model interpolations for individual species and estimated primary production between 2000 to 2012 from Satellite data (MODIS). We tested richness-productivity relations across Europe and across taxonomic groups and assessed the level of spatial congruence of productivity and biodiversity using quantile ranges and overlay analysis. Productivity ws positively correlated to biodiversity except for bird diversity which showed a weak negative correlation. We found large areas of overlap between productivity and biodiversity (except for bird diversity) in the Mediterranean and temperate regions. Areas with high diversity and low productivity are mostly located on the Iberian Peninsula and the Balkan ranges except for birds which had these areas in the boreal areas of Europe.

3. Assessing phytolith composition across vegetation types in the Netherlands

Iris de Wolf, Crystal McMichael, Annemarie Philip, William Gosling
University of Amsterdam

Phytoliths are silica-based microfossils commonly used in palaeoecological reconstructions of past vegetation change. The variation in phytolith assemblages across vegetation types in modern north-western European systems is relatively unknown, obscuring their interpretation in palaeoecological reconstructions. Here, we characterize phytolith assemblages within and between wetlands, forests and agricultural areas in the Netherlands to provide reference data that can be used in qualitative or quantitative reconstruction of past vegetation change. We characterized the phytolith assemblages from soil surface samples across forested, wetland, and agricultural habitats. We compared the percentages and concentrations of phytolith types using ANOVAs and assessed the (dis)similarity between samples using multivariate analyses.
Phytolith assemblages from forests, wetlands and agricultural fields were distinguishable from each other. Agricultural fields had significantly higher amounts of several grass silica short cells and disturbance or crop phytoliths compared with other habitat types, whereas forests settings had significantly higher amounts of different arboreal phytoliths. Wetlands could be identified by significantly higher amounts of Cyperaceae phytoliths and other GSSCs. The distinguishability of phytolith assemblages both within and between forested, wetland, and agricultural areas of the Netherlands suggest that phytoliths can be a powerful tool in inferring past environmental change.

4. Understanding the relationship between dispersal and range size

Adriana Alzate, Renske Onstein
German Centre for Integrative Biodiversity Research

Understanding what drives the vast variability in species range sizes remains an outstanding question in ecology. The theoretical expectation of a positive dispersal-range size relationship has received mixed empirical support, despite dispersal being one of the most prominent hypothesized predictors. Here, we synthesized results from 86 studies examining the effect of dispersal on range size for plants and animals in marine, terrestrial and freshwater realms. Overall, we found that dispersal had a positive effect on range size, but its effect was highly dependent on the clade and dispersal-related traits studied. Despite potential differences in habitat connectivity, we did not find an effect of realms. Moreover, the overall strength of the dispersal-range size relationship is influenced by how range size was measured, whether phylogenetic relationships were considered, and the taxonomic breadth of the study clade. Our synthesis emphasizes the importance of considering different aspects of the dispersal process -departure, transfer, settlement- and the traits associated with them. Furthermore, ecological niche, environmental tolerance and evolutionary components, such as time for range expansion and past geological-environmental dynamics, can additionally influence current dispersal-range size patterns. We therefore call for a more integrative view of the dispersal process and its causal relationship with range size.

5. Dutch landscapes are losing insect-pollinated plants

Kaixuan Pan, Leon Marshall, Koos Biesmeijer, Geert de Snoo
Leiden University

Studies have reported alarming declines of both insect and plant biodiversity. However, it is still unknown whether these trends are linked. Therefore we investigated whether there are different trends in plants with different pollination modes. We found that the proportion of (obligately) insect pollinated plants has declined while (obligately) wind pollinated plants have increased over the last century by combining vegetation plot data and plant pollination traits. This proportional change reflects absolute decline in the number of insect pollinated species and increase in the number of wind pollinated species over time. The accumulating evidence for declines in insect-pollinated plants and insect pollinators is an alarming message.

6. The future of biogeographical research in the Netherlands and Belgium

Sietze Norder, Majoi de Novaes Nascimento, Kenneth Rijsdijk
Leiden University

There is a long tradition of biogeographical research and monitoring in the Netherlands exemplified by the work of Melchior Treub who started the longest-lasting biodiversity monitoring effort on the island of Krakatau. Today, biodiversity in the Netherlands is severely threatened, mirroring the global biodiversity decline and also the loss of cultural diversity. The underlying drivers of this decline, and the prioritization of conservation and restoration areas, are inherently spatial. Therefore sound knowledge of biogeographical theories, methods, and monitoring approaches are essential to bend the curve of biodiversity loss. Through this discussion we want to explore the opportunities for collaboration between Dutch and Belgian biogeographers, as well as increasing the visibility of the discipline.

3d: Connectivity between different life stages in aquatic/marine animals

Conveners: Ingrid Tulp (Wageningen University & Research)
Allert Bijleveld (University of Groningen)
Klemens Eriksson (Royal Netherlands Institute for Sea Research)

1. The role of spatial habitat heterogeneity as driver for diversity and abundances of young-of-the-year riverine fishes

Twan Stoffers, Antonie D. Buijse, Gertjan W. Geerling, Johan. A. J. Verreth, Leopold A. J. Nagelkerke
Wageningen University and Research

Spatial habitat heterogeneity, river-floodplain connectivity, and the limited mobility of YOY fish are key aspects influencing growth and survival of early life stages of riverine fishes and are increasingly recognized as part of a well-functioning nursery area. When both local fish biodiversity and habitat heterogeneity are high, and river-floodplains and individual habitat patches are inter-connected, river fish populations may exhibit high levels of resilience against flood pulses, global warming and other environmental changes. Conceptual models on the relationships between spatial configuration of habitat patches and local fish biodiversity and abundances in riverine systems have been rarely tested with empirical data. In this study we related the quality and spatial configuration of (shoreline) habitat patches to the diversity and abundance of YOY (young-of-the-year) riverine fishes, using spatially and temporally high-resolution data. Between 2017-2020 we collected data from 46 floodplain restoration projects and 26 control sites in the main channel of the lower river Rhine (the Netherlands), resulting in 2194 sampling events. We characterised the environment on different spatial scales (sample (~0.1 km), restoration project (~1.0 km) and river level (~10 km)), and related 43 habitat variables to YOY fish abundances and species richness of the local riverine fish community via a stepwise multivariate approach. Here we present preliminary results of our approach and discuss which aspects of the local environment and its heterogeneity are most critical for different indicators of riverine fish community status in the lower river Rhine.

2. Fish movements and habitat selection in response to lake restoration project Marker Wadden

Casper H.A. van Leeuwen, Joep J. de Leeuw, Elisabeth S. Bakker
Radboud University Nijmegen

Habitat heterogeneity and connectivity are essential for fish to complete their life cycle, because habitat requirements of most species change during their ontogeny. A lack of heterogeneity in local conditions can therefore be expected to induce larger-scale movements, while movements can remain local in sufficiently heterogeneous environments. We investigated fish movements and habitat selection for different life stages in relation to changes in habitat heterogeneity in lake Markermeer, the Netherlands. Lake Markermeer is a homogeneous shallow freshwater lake with declining bird and fish populations, in which recently a five-island archipelago has been constructed from the lake's own sediments called "Marker Wadden". This newly created 1000-ha mosaic of habitat types added gradual land-water transitions, variation in water depths, shelter from wind and deep sand excavations to the homogeneous lake. We assessed habitat selection of juvenile fish at local spatial scales and tracked five species of adult fish with acoustic telemetry at local and landscape spatial scales. We report how adding heterogeneity to homogeneous freshwater environments can affect fish during different phases of their life cycle, how this influences their movements at different spatial scales, and provide a first outlook on how this may ultimately affect their populations.

3. Urban glass eels in a man-made fragmented catchment: migration from large ship locks in the North Sea Canal to Amsterdam and surrounding polders

Ben Griffioen, Erwin Winter, Olvin van Keeken, Tony Wilkes, Patrick Deitelzweig, Xander de Boer, Britt van Houten
Wageningen University

Connectivity between sea and freshwater inland habitats is heavily obstructed by anthropogenic barriers leading to a high pressure on diadromous fish populations including European eel (*Anguilla anguilla*). Glass eel migration behaviour such as selective tidal stream transport used in estuaries and free running river systems is not possible in regulated water systems due to absence of tidal currents. A better understanding of glass migration behaviour in highly regulated water systems is needed to take proper mitigation actions. To quantify abundance, passage efficiency and migration behaviour along the canal, a mark-recapture experiment was conducted by tagging 3797 glass eels near a large sluice-complex and 2663 glass eels along a 28km long brackish canal in the Netherlands in spring 2018. The results show that glass successfully passed the sluice-complex using the ship locks and showed migration towards the very end of the canal. They migrated with an average speed of 0.6-0.8 km/day with peaks of 1.8 km/day. We observed counter-current swimming behaviour to further inland polder areas as well as redistribution along the canal if migration was not successful to inland polder areas. The obtained knowledge can contribute to efficient glass eel migration and settlement in highly regulated inland water systems.

4. Continuous acoustic measurements: the behaviour and occurrence of small pelagic fish in the inlet of the Wadden Sea revealed

Margot Maathuis, Bram Couperus, Jan Jaap Poos, Ingrid Tulp and Serdar Sakinan
Wageningen University & Research

Shallow marine estuaries are important coastal habitats for early life stages of many fish species, both fish inhabiting the seafloor (demersal), and fish living in the water column (pelagic). The latter also provide the most important food base for fish eating birds. Recording pelagic fish requires acoustic techniques. However because applying acoustic methods is often difficult in shallow areas, small pelagic fish (SPF) received little research attention in contrast to demersal fish. The Wadden Sea in Europe is such a large shallow marine estuary where the habitat use and connectivity of SPF between the North- and the Wadden Sea is poorly understood. To study the SPF dynamics of the area, we deployed an autonomous echo-sounder, pinging vertically upwards, combined with a water current profiler. This setup provided measurements every 90 minutes of fish in the entire water column for over 14 months. The high temporal resolution of the acoustic data enabled resolving dynamics of SPF in relation to tidal flow, water temperature and the temporal rhythms therein, from hourly to seasonal scales. Fish aggregation patterns, such as compactness and vertical distributions, as well as swimming directions and speed of fish were used to infer behavioural aspects. Furthermore, studying biomass over time provided insight in large scale patterns in this area, such as migration. In this talk, first results on SPF behaviour and the connectivity between the two waterbodies will be presented. This will ultimately enhance our understanding of the function of the Wadden Sea ecosystem in the life cycle of various small pelagic fish species.

5. Synchrony in plaice larval supply to European coastal nurseries by different North Sea spawning grounds

Henk W. van der Veer, Johannes IJ. Witte, Patrick Flege, Johan van der Molen, Suzanne S.H. Poiesz
Royal Netherlands Institute for Sea Research

Juvenile fish survival, growth and recruitment has been thoroughly studied in coastal nursery areas whereby, over the years, not only tools and methodologies have changed but also the knowledge on the anthropogenic, biotic and abiotic factors influencing these factors. Sustainable management of these areas rely on detailed knowledge on when, where and how adult fish reproduce. Hydrographic features, such as currents in the North Sea, connect spawning areas in the open sea with coastal nursery areas, such as the coast of the North Sea and the Wadden Sea. In plaice, interannual differences in connectivity and settlement patterns of larvae is thought to be caused by variability in hydrodynamic circulation of developing eggs and larvae during drift. In this study 23 sampling stations along the Dutch coast and Wadden Sea were visited over 6 years during peak settlement of plaice larvae. Based on daily rings counts of sagittal otoliths settlement patterns of plaice larvae at the various stations was reconstructed. Similarity in settlement pattern between stations was considered to reflect a common origin of the larvae (i.e. from the same offshore spawning area). 3 D hydrodynamic water movement models were applied to back calculate the location of the spawning areas for plaice larvae of the various stations.

6. Temporary summer residency of migratory fishes in the western Dutch Wadden Sea

Jena E. Edwards, Hendrick V. Winter, Tom Buijse, Allert I. Bijleveld
Royal Netherlands Institute for Sea Research

For migratory fish species, the Wadden Sea serves as both a seasonal habitat and as a 'swimway' that facilitates transitional movements between marine and freshwater environments. However, our current understanding of fish movement patterns and habitat use in this region remains limited, obscuring our ability to identify the potential causes and consequences of observed declines. Biotelemetry techniques allow researchers to monitor both small-scale movements and large-scale migratory patterns remotely, for prolonged periods, and across regions encompassing multiple habitat types, thereby informing management and conservation approaches. We here use acoustic telemetry to monitor the movements and seasonal residency of migratory adult fishes during the summer growth period in the western Dutch Wadden Sea. Movement data from 131 individuals belonging to three target species were analyzed to determine the timing of departure from the region and to examine the scales of localized movements and the occurrence of activity hotspots during the summer growth period. By defining important habitats and movement pathways throughout the Wadden Sea, we can identify potential bottlenecks wherein fish may be vulnerable to increased mortality or factors limiting carrying capacity. These findings will guide future conservation efforts aimed at enhancing fish survival and population stability in this important ecosystem.

3e: Open session

Conveners: Laurens Poorter (Wageningen University & Research)

1. **Genomic analyses point to a low evolutionary potential of prospective source populations for assisted migration in a forest herb**
   Frederik Van Daele
   KU Leuven

Climate change is increasingly impacting temperate forest ecosystems and many forest herbs might be unable to track the changing climate due to dispersal limitations. For example, we found that the self-incompatible deciduous forest herb Primula elatior is projected to lose 46.4 ± 13.9% (mean ± SD of climate change scenarios) of its total distribution area due to climate change by 2050 and an additional 15.6 ± 1.7% (mean ± SD) of the distribution would not be accessible through plant migration. Forest herbs with a low adaptive capacity are prone to climate change effects and may benefit from conservation strategies mitigating dispersal limitations and evolutionary constraints, such as assisted migration. To assess the vulnerability of forest herbs to climate change it is key to evaluate their adaptive potential and to quantify the genetic offset. To this end, we quantified climate change vulnerability metrics using single nucleotide polymorphisms (SNPs)along a latitudinal gradient of Primula elatior. Southern populations displayed a sharp genetic turnover and a considerable amount of local adaptation under diversifying selection was discovered. However, most of the outlier loci could not be linked to climate variables (71%) and were likely related to other local adaptation drivers, such as photoperiodism. Furthermore, specific adaptations to climate extremes, such as drought stress, could not be detected. Populations in the south of the distribution area had high sensitivity to climate change due to a low adaptive capacity and a moderate genetic offset, while central European populations were sensitive due to a high genetic offset. We conclude that assisted migration with southern source populations could bear significant risk due to local maladaptation and a low adaptive capacity. Local admixture and restoration of ecological connectivity to increase the adaptive capacity and assisted range expansion to suitable habitat in the north could be advised as potential mitigation strategies.

2. **Light competition and tree height growth during tropical forest succession**
   Tomonari Matsuo, Miguel Martínez-Ramos, Frans Bongers, Masha T. van der Sande, Lourens Poorter
   Wageningen University and Research, Forest Ecology and Forest Management group

Plants in closed vegetations compete strongly for light and prioritize height growth to attain a position in the canopy to improve light conditions. Light competition is especially strong during forest succession, as there is a rapid build-up of vegetation with concomitant changes in the vertical light profile. We evaluated successional changes in height growth allocation patterns for trees from different forest light strata in Mexican tropical rainforest. Fourteen secondary forest stands differing in age (1-25 years) since agricultural abandonment were monitored for seven years. We estimated relative light intensity (RLI) for each stand and census year, and categorized trees into three forest light strata; understory trees (RLI<33%), sub-canopy trees (33%<RLI<66%), and canopy trees (RLI>66%). Understory and sub-canopy trees allocated more to height growth than canopy trees, probably because understory trees are strongly light-limited, and because sub-canopy trees occur in the position in the vertical light profile where light attenuation rate is strongest, with the largest gain in light conditions for a given height growth. Canopy trees are not light-limited. Height growth allocation declines during succession, probably because the vertical light gradient becomes shallower, and because pioneer species with strong vertical growth are replaced by later-successional species with more lateral growth.

3. **Growth responses to severe droughts for assessment of forest growth potential under future climate in the Netherlands**
   Meike Bouwman, Paul Copini, Frits Mohren, Jan den Ouden and Ute Sass-Klaassen
   Wageningen University and Research, Forest Ecology and Forest Management Group

Over the past decades, droughts and other disturbances related to climate change have impacted forests worldwide, resulting in deprived growth, vitality loss and eventually mortality. The 2018 summer drought was exceptional, breaking long-term records in large parts of central and northern Europe including the Netherlands. In this study, we analyzed the growth responses of 5 coniferous and 3 broadleaved tree species in Dutch forests to severe and extreme drought events. This was done by analyzing tree-ring widths of tree species growing under different site conditions and quantifying growth responses to drought episodes with resilience indices. We found that all studied species, except sessile oak, showed significant growth reductions during drought years, compared to non-drought years. Growth resilience to drought, including its components resistance and recovery, varied between tree species, depended on drought timing and severity and, to a lesser extent, local site conditions. Finally, resilience to recent droughts was found to be lower than to episodes occurring more than 2 decades ago. Our results provide an outlook on future growth potential of the species studied under projected climate change for the Netherlands.

4. **Plant and plot-level diversity of chemical profiles in a tansy plant field population influences aphid occurrence**

Lina Ojeda-Prieto, Robin Heinen, Wolfgang Weisser
Terrestrial Ecology Research Group, School of Life Sciences. Technical University of Munich, Freising, Germany

Host plant selection by phytophagous insects is mediated by the interaction between insects and plant metabolites. However, little is known about the role of plant chemical profiles in host plant discrimination by specialist and generalist aphids. Tansy plants are well-known for being highly diverse in the blend and individual abundance of secondary metabolites. We defined six chemotypes by the terpenoid profiles produced by the plant, which were planted in plots with different plot-level chemotypic diversity. We recorded aphid colonization and occupancy events weekly on each plant. Overall, we observed strong effects of chemotypes on the occurrence of two specialized aphid species. For instance, *Uroleucon tanaceti* and *Macrosiphoniella tanacetaria* aphid numbers decreased on chemotypes whose dominant compounds were Chrysantenyl acetate, and Eucalyptol and O-Cymene, respectively. We found that different plant chemical profiles might not influence plant occupancy in the case of the specialist *Metopeurum fuscoviride* and the generalist aphids Aphis fabae and *Brachycaudus cardui*. We also observed a higher number of both specialist and generalist aphids at higher levels of plot-level chemical diversity. We show that intraspecific phytochemical variation structures ecological communities, as different aphid species respond differently, and that specific metabolites might explain variation in aphid occurrence over the season.

5. **FSC-certified forestry benefits large and critically endangered wildlife compared to non-FSC**

Joeri Zwerts
Utrecht University

Over half of all tropical forests are exploited for timber, which facilitates hunting for wildlife over extensive areas. Forest certification addresses hunting in its regulations and positive effects have been demonstrated at the local level or for one or few species at a time, but well replicated studies for the whole mammal community are lacking. Demonstrating impact is an essential component of any certification system; this is especially pertinent given the investments by both timber producers and consumers. Here we present an analysis on the impact of FSC certification on wildlife, using 1.3 million camera trap photos of 55 mammal species gathered in seven FSC-certified and seven non-FSC forestry concessions in Western Equatorial Africa. We predicted, and found strong support for, higher hunting pressure and concomitant negative effects on larger-bodied species in non-FSC concessions compared to FSC concessions. We found greater abundances of large mammals in FSC concessions with the effect being most pronounced for species weighing over 10 kg. Our data also show that FSC-certified concessions contain higher abundances of high conservation priority species such as forest elephants, large carnivores and primates. Non-FSC concessions are dominated by rodents and other small species, resulting in a lower total faunal biomass. Our findings provide consumers, governments, and NGOs with convincing evidence that responsible, FSC-certified timber extraction practices are far less damaging to the mammal community than uncertified logging management practices. This study provides concluding evidence that FSC-certified forest management should become the norm for timber extraction, since inaction will result in empty forests dominated by rodents and other small species.

6. **Bugs at your service: recent insights into biocontrol and pollination in crop production systems**

Felix Bianchi
Farming Systems Ecology Group, Wageningen University & Research

Mobile arthropods provide important ecosystem services to support crop production, including pest suppression and pollination. These arthropods depend on the life-support functions provided by the landscape, but at the same time intensive management practices in the landscape may pose threats for these arthropods. In this presentation I will give an overview of the work of my group in the past years and highlight how pest, natural enemy and pollinator populations are influenced by interactions between resource availability, insecticide use and their movement.

Parallel Session 4

4a: Aiding nature restoration by facilitation

Conveners: Ralph Temmink (Utrecht University)
Jasper Wubs (Netherlands Institute of Ecology)
Bjorn Robroek (Radboud University Nijmegen)

1. **Plant facilitation: linking ecological theory to management action to aid nature restoration**
Rob Brooker
The James Hutton Institute

The role of plant-plant facilitation in structuring ecological communities and regulating ecosystem function has been a high-profile topic in plant ecology during the last 25 years. This presentation will provide an overview of how our understanding of beneficial plant-plant interactions has developed during this period. It will consider how fundamental work undertaken in more severe environments - for example alpine and arctic ecosystems - set an initial theoretical framework. It will then explore how this initial framework has been extended, both through a recognition of the occurrence and role of facilitative interactions in more productive ecosystems, and by increasing interest in the importance of facilitative interactions as a component of ecosystem restoration. It will conclude by discussing some of the extant knowledge gaps in this field which are most important to future efforts to restore nature and meet international commitments for biodiversity conservation.

2. **Making sense of plant-soil biota interactions for nature restoration**
Jasper Wubs
Netherlands Institute of Ecology

The UN Decade on Ecosystem Restoration has started and it is clear that active restoration measures are needed to reverse biodiversity decline in many situations. Despite large species level variability, interactions between late-successional plants and soil biota can be strongly facilitative on the level of communities. This situation can be leveraged to improve restoration success by co-introducing soil biota together with appropriate plant propagules, as was shown previously with soil inoculation in the Dutch Veluwe area. However, success is far from universal. In this talk I will explore the factors that drive success of soil translocation on plant community restoration. Drawing on the primary data from 46 field experiments conducted around the world, the results show that co-introduction of seeds and soil biota improves average restoration success, but also that the variability in outcomes is huge. Partly this is due to our limited knowledge of soil biodiversity. To improve this situation, NIOO has recently co-launched the IJkcentrum Bodembiodiversiteit, a centre to benchmark the Netherlands' soil biodiversity. I will discuss how this centre will contribute to enhancing facilitative interaction in nature restoration.

3. **Local perennial plants affect occurrence and traits of annual grasses along an environmental gradient**
Megan Korte, Antonio Manzaneda, Luisa Martinez, Tamatha Patterson, Rampal Etienne, Louis van de Zande, Christian Smit
University of Groningen

Positive plant interactions are well known to influence plant community dynamics, especially in stressful habitats. Successful restoration in stressful habitats requires a more thorough understanding of the mechanisms driving plant-plant interactions in patchy landscapes. What is less well-known, is if neighbouring perennial plants can drive differences in the spatial association and life-history traits of two closely related annual grasses along an aridity gradient in southern Spain. We found that as the degree of aridity increased, both *Brachypodium* species were less associated with neighbouring perennial plants. We also found that plants collected outside perennial plants were taller, had higher seed numbers and further, in controlled conditions from our least arid site, flowered more rapidly than plants found underneath perennial plants. We conclude that in patchy landscapes dominated by perennial plants, both annual grasses respond, in partly unexpected ways, to both the macroclimate (aridity gradient) and the microclimate as provided by neighbouring perennial plants. Future research should, therefore, incorporate such neighbourhood effects on annual plants, as these may have consequences for restoration success to ongoing rapid environmental changes.

4. How facilitation by an unpalatable rush affects the invasive grass *Elytrigia atherica* in a salt marsh

Isabelle P.R. Buyens, Chris Smit, Peter C. le Roux
University of Groningen

Plant-plant facilitation and competition are key processes structuring the vegetation development of salt marshes. Variations in fine-scaled plant interactions scale-up to larger vegetation spatial patterns and ecosystem functions as a whole. For instance, in the presence of grazers, associational resistance provided by patches of herbivore resistant species can have large impacts on vegetation composition. However, how plant interactions are impacted by species traits, biotic stress and environmental severity in dynamic systems remains poorly understood. Using a reciprocal transplant experiment we investigated how two ecotypes of the grass *Elytrigia atherica* is impacted when planted within and outside of Juncus maritimus patches occurring in the eastern salt marsh of Schiermonnikoog, the Netherlands. Although the survival and height of *E. atherica* plantings was not affected by the ecotype, plant height was lowest outside of patches in the grazed marsh and not affected by inundation frequency. This contrasts to the survival of the plantings which was highest in the grazed marsh and low inundation frequency. We found that through associational resistance, J. maritimus facilitates the height of *E. atherica* but not the survival. Understanding fine-scaled plant-plant interactions and the mechanisms of facilitation may inform best management practices for conservation and restoration.

5. Facultative mutualism facilitates European seagrass meadows

Jimmy de Fouw, Marianne Holmer, Tjisse van der Heide
Radboud University Nijmegen, Royal Netherlands Institute for Sea Research

Coastal ecosystem functioning often hinges on habitat-forming foundation species that engage in positive interactions (e.g. facilitation and mutualism) to reduce environmental stress. Seagrass meadows are important foundation species of coastal zones, but are rapidly declining with losses typically linked to intensifying global change-related environmental stress. However, there is a growing evidence that loss or disruption of positive interactions can amplify coastal system degradation as it compromises the ecosystem's stress mitigating capacity. Multiple recent studies highlight that seagrass can engage in a facultative mutualistic relationship with lucinid bivalves that alleviate sulphide toxicity. Yet, its current generality, and how the strength and relative importance of the mutualism depend on environmental conditions remains to be investigated. We investigate for the first time the importance of the seagrass-lucinid mutualistic interaction in a continental-scale field survey across Europe. We found that the seagrasses *Zostera noltii* and *Zostera marina* are associated with the lucinid bivalve *Loripes* orbiculatus across a large latitudinal gradient. Our survey confirms that the presence of the lucinids have a positive effect on seagrass biomass by mitigating sulphide stress. Therefore, we argue that this seagrass-lucinid mutualism should be more integrated into seagrass conservation practices to improve restoration success and resilience to global change.

6. Five years Marker Wadden: creating gradients for lake restoration

Joep de Leeuw, Ruurd Noordhuis, Sacha de Rijk
Wageningen Marine Research

Marker Wadden is a small archipelago of 5 islands created in freshwater lake Markermeer between 2017 and 2021. The islands provide land-water transition zones of mainly nutrient-rich clay soils protected from wind and wave exposure by sand ridges. Additionally, the archipelago provides shelter in the lake area on the lee-side which promotes sedimentation of suspended silt in the lake, thereby creating a turbid to clear water gradient. Research on the productivity and ecological functioning of both gradients revealed rapid developments of pioneer vegetation, settlement of breeding bird colonies, and foraging areas for waders and waterfowl, and a gradual development of littoral and submerged vegetation between the islands, indicating a rather productive aquatic-terrestrial transition zone. The first indications for the establishment of a turbid to clear water gradient were noted, but so far, ongoing building activities associated with creating new islands partly obscured these developments and also incurred (temporal) ecological impacts on a larger scale in the lake via resuspension and sediment transport. In the meantime, the presence of new habitat and its strategic location have stimulated several bird species to use the islands as stepping stones between other breeding and feeding areas in the vicinity.

4b: Carbon and nutrient cycling

Conveners: Mandy Velthuis (Radboud University Nijmegen)
Suzanne McGowan (Netherlands Institute of Ecology)

1. Can a living fossil save our soils?

Renske Vroom, Bas van de Riet, Alfons Smolders, Leon Lamers, Sarian Kosten
Radboud University Nijmegen

New nature in The Netherlands is often developed on former agricultural fields. A big challenge in this transition is the agricultural nutrient legacy, especially of phosphorous (P), resulting in soil and water quality issues and low biodiversity.
To overcome this challenge in a novel, cost-effective way, *Azolla filiculoides* (water fern) could be cultivated to simultaneously extract P and sequester carbon. *A. filiculoides* is excellent at accumulating P due to its nitrogen fixating capacity and high growth rates. To characterize the potential of this approach, we cultivated *A. filiculoides* on 15 inundated agricultural soils which were high in Olsen-P. We measured soil, water and plant nutrient dynamics and methane emissions in three treatments: no vegetation, *A. filiculoides* that was harvested weekly or *A. filiculoides* that accumulated during the experiment (2 months).
We found that Azolla cultivation was successful when soil NaCl-extractable P was sufficiently high (>50 µmol P kg FW^{-1}) and surface water pH was sufficiently low (<6). *A. filiculoides* effectively extracted P, and a weekly harvest resulted in high surface water O_2 concentrations and low CH_4 emissions. We conclude that cultivating *A. filiculoides* shows potential in the transition of agriculture to nature, while recovering P from former agricultural soils.

2. Co-composting rose waste, assessing the potential as a sustainable waste management strategy

Evy Annelie de Nijs, Lea Maas, Roland Bol, Albert Tietema
University of Amsterdam

The limited usage of rose waste makes rose farming far from a sustainable circular industry. The re-use of horticultural waste is currently limited due to unfavorable properties such as high lignin content and polyphenol levels which hamper an effective composting process.
The aim of our study was to investigate the potential of co-composting rose waste with other green wastes or mature compost to obtain valuable compost. We closely monitored the evolution of 5 mixtures in triplo in a small-scale drum composting system and assessed *in-vivo* disease suppression.
All mixtures resulted in stable and mature compost containing sufficient nutrients after 180 days, with a C/N below 10, decrease in polyphenols ≥70% and an increase of CEC ≥100%. Sanitation requirements were not met due to the small volume, which is common for small-scale set-ups. Mixtures with mature compost added reacted faster but less pronounced in terms of final values. Disease suppressing assay of mature rose compost with several common rose diseases showed strong growth reduction to complete prevention, indicating high disease suppressive capacity.
Despite the ligneous character of rose waste, high quality compost was obtained indicating the potential of co-composting rose waste to improve the circular economy objectives of the horticultural sector.

3. Aquatic plants can counteract eutrophication and greenhouse gas emission by wastewater effluent polishing

Lisanne Hendriks, Annelies Veraart, Fons Smolders
Radboud University Nijmegen

Nutrient concentrations in treated municipal wastewater effluent often are many times higher than critical nutrient values of the waterbodies where it is discharged into, causing eutrophication and substantial greenhouse gas emission at discharge sites, and essential (and non-renewable) nutrients to be lost. By adding an extra wastewater treatment step, in the form of aquatic plants, excess of nutrients can be removed. Not only are aquatic plants directly causing nutrient removal by nutrient uptake, they change water conditions and provide surface for biofilm formation and therefore also indirectly remove nutrients, especially by nitrification and denitrification. Harvesting of the plants' biomass results in nutrients being permanently removed from the wastewater effluent, therefore this effluent polishing can contribute to lower eutrophication and greenhouse gas emission in natural waterbodies.

4. **Multiple-effects of combatting eutrophication on CH_4 emissions from a small pond: macrobiological, microbiological and biogeochemical insights**
Quinten Struik, José Paranaíba, Annelies Veraart, Berber Meulepas, Martyna Glodowska, Guido Waajen, Sarian Kosten
Radboud University Nijmegen

Wetlands are sources of methane (CH4), a potent greenhouse gas produced via methanogenesis in anoxic sediments. Methane production and emission to the atmosphere are enhanced by eutrophication. Various measures are taken to combat eutrophication, including dredging and the addition of phosphorus-binding substances. We examined the effects of dredging and phosphorus-binding substances (Fe(II)Cl2, Phoslock®, Aqual-P®) on the submerged macrophytes, microbial community and CH4 emissions using an experimental mesocosm set-up with the mentioned treatments and control (all in quadruplicate). Our preliminary results suggest that, on the short-term, dredging performs better in reducing CH4 emissions, resulting in an average, 500% decrease in diffusive CH4 emission compared to control. However, when organic carbon becomes available again, dredged mesocosms show peaks in CH4 emission, which may be explained by the (s)lower recolonization of methanotrophs in the sediment. Moreover, a strong negative correlation between diffusive CH4 emission and submerged macrophyte abundance was observed, with the plant-related CH4 oxidation potential being highly dependent on macrophyte species. Lastly, we hypothesize that the input of Fe(II)Cl2, (besides indirectly enhancing oxic CH4 oxidation through water-quality improvement) enhances iron-dependent anaerobic CH4 oxidation. Concluding, besides combatting algal blooms, eutrophication mitigation measures also have the potential to reduce CH4 emissions from aquatic systems.

5. **Greenhouse gas emissions from dredged material and potential mitigation measures: an experimental approach**
Judith van der Knaap, Gijs van Dijk, Mark van Mullekom, Alfons Smolders, Sarian Kosten
Radboud University Nijmegen

World-wide, billions of cubic meters of material are dredged from aquatic systems annually. Dredged material is either repurposed, relocated within the system, disposed, or spread over land. While greenhouse gas (GHG) emission of dredging activities is receiving increasing attention, surprisingly little is known about the emissions from the dredged material itself. We investigated carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) emissions from dredged material with different chemical compositions collected at four locations and subjected them to different treatments to investigate potential mitigation measures. For 85 days, the material was either subjected to drying, kept inundated, or subjected to drying with zeolite addition. We found that drying material emitted significantly more CO_2 than inundated material (averages: 2513 and 1558 mg m^{-2} day^{-1}, respectively) and total GHG emissions in CO_2-equivalents were on average 1.8 times higher in drying material. Moreover, dredged material with high ammonium concentrations emitted more N_2O compared to material low in ammonium. N_2O emissions could be reduced considerably (up to 4.4 times) by the addition of zeolite in freshwater material. Our findings indicate that emissions from dredged materials can be substantial and that differences in composition influence GHG emissions and determine which mitigating measure is most effective.

6. **Greenhouse gas emissions from Dutch inland waters, how to manage to reduce emissions?**
Martine Kox, Stefan Jansen, Wouter van der Star, Sacha de Rijk, Tineke Troost, Emma van Deelen, Bob Brederveld, Sebastiaan Schep, Moni Poelen, Gijs van Dijk
Deltares knowledge institute

Inland (eutrophic) waters can be relevant sources of greenhouse gas emissions. Within the project BlueCAN, commissioned by water authorities and TKI Deltatechnology, we explored the magnitude and drivers of greenhouse gas fluxes from Dutch inland waters. Ultimately, the goal is to identify parameters that can be influenced by (water)management and abate greenhouse gas emissions. The approach consists of both an experimental set-up and a modelling efforts.
We sampled sediment cores from 12 different areas (each site 5 locations) covering a variety of water types and abiotic conditions. Fluxes of CO2 and CH4 were measured in time using a GHG flux analyzer under controlled condition in the lab. The soil and porewater characteristics were analyzed to link to the GHG fluxes and identify drivers. The modelling approach is based upon two water quality models PCLake and Delwaq, of which a meta-model was created using the strongest points of each model.
Results show that finding the critical parameters that drive GHG fluxes is complex. By combining emissions from laboratory experiments with modelling efforts however, we are able to develop a first quickscan-tool that gives more insight into the quantities of greenhouse gas emissions for surface waters and insight in potential mitigation measures.

4c: Research Infrastructures – Making Science Happen

Conveners: Niels Raes (NLBIF – Naturalis Biodiversity Center, Leiden)
Elaine van Ommen Kloeke (Naturalis Biodiversity Center, Leiden)

1. 20 years of the Global Biodiversity Information Facility (GBIF) and the importance of citizen science

Niels Raes[1], Dylan Verheul[2], Szabolcs Nagy
[1]*NLBIF – Naturalis Biodiversity Center*
[2]*Observation International / Waarneming.nl*

20 years after the establishment of the global biodiversity information facility - GBIF - the GBIF Governing Board commissioned an independent review. In its summary of conclusions, the review calls GBIF "the most comprehensive, openly available, application-agnostic (most unbiased), easiest-to-use, and modern access point to known digital species occurrence data." Here we present some of the key successes of GBIF over the past 20 years to where we stand today with GBIF sharing 1.9 billion biodiversity records, with a daily growth of almost 1 million records, daily downloads of close to 3 billion records resulting in almost four published SCI papers daily in a wide range of scientific disciplines.
Approximately 75% of all records at GBIF represent human observations. Observation.org is one of the oldest Dutch citizen science platforms in the world with over 170M records gathered over the past 14 years. These observations have been validated by experts, knowledge rules and deep learning models. Observation.org is designed to support various citizen science and scientific projects; mobile apps and websites can be configured with minimal to no programming effort to enable biodiversity monitoring, including recording measurements, media and metadata. We will explain the basics of our platform and aim to engage more closely with the Dutch ecological community, especially on how to use citizen science data to gain more biodiversity knowledge.

2. Catalogue of Life: A global infrastructure for taxonomic names services

Olaf Bánki & Chantal Huijbers
Naturalis Biodiversity Center, Catalogue of Life

Catalogue of Life (COL) is an international collaboration existing for over 20 years. The COL Checklist aims to provide researchers, policy-makers, environmental managers, and the wider public with a consistent and up-to-date global index of species names. At present, the COL Checklist has reached just over 2 million accepted species names, a similar number of synonyms, homonyms, and prior combinations. This is carried by an international community of 165 taxonomic data sources.
COL has developed a new infrastructure in collaboration with the Global Biodiversity Information Facility, consisting of a public portal, ChecklistBank, and a new API. The new COL infrastructure functions more efficiently, aims to better facilitate the taxonomic community, and provides a more sustainable service for users at all scales. COL provides stable taxon name identifiers, and is shifting to open data licenses.
The COL Checklist serves as a valuable taxonomic names resource for various biodiversity data research infrastructures as well as some policy initiatives like the European Environmental Agency. With its new infrastructure, COL will also develop tools that serve users more directly, such as name matching tools. This presentation will review recent developments and the roadmap for future services for which we invite your feedback.

3. DiSSCo - Weaving Natural Scientific Collections into the Web of Environmental Data

Wouter Addink
Naturalis Biodiversity Center, DiSSCo

DiSSCo (Distributed System of Scientific Collections) is a research infrastructure (RI) under development that will provide services for the global research community to support and enhance physical and digital access to the natural history collections in Europe. These services include training, support, documentation and e-services.
The e-services are digital services provided by the RI community which will make use of a novel FAIR Digital Object (FDO) infrastructure (see also: https://FAIRDO.org) serving Digital Specimen from the European collections. This infrastructure provides a unique access point for integrated data analysis.
The e-services will provide enhanced interpretation, curation, annotation and use of rich specimen information by novel mechanisms for community curation and visualisation.
The FDO infrastructure enables specimen data to be (re-)connected with genomic, geographical, morphological, taxonomic and environmental information through the Digital Specimen, making them Digital Extended Specimens. Being designed to be FAIR, these objects are not only Findable, Accessible, Interoperable and Reusable but also Fully AI Ready. Being actionable objects, both humans and machines can interact with them, allowing services to enrich the data objects through rapid information extraction and annotation, data linking and species identification. The specimen data interconnected with derived and related information will accelerate scientific discoveries.

4. **UNLOCK – integrated biodiscovery-, bioreactor- and FAIR data facilities to unlock microbial diversity for society**
Alette Langenhoff, Robbert Kleerebezem, Peter Schaap and Hauke Smidt
UNLOCK consortium

UNLOCK is an experimental and data platform, enabling breakthrough research and knowledge sharing on natural and synthetic microbial communities. Such microbiomes are of key importance at different scales in our society, ranging from individual-based health issues related to microbiomes inhabiting our body, to global greenhouse gas (i.e. CH4 and N2O) emissions. With UNLOCK, Wageningen University and Delft University of Technology integrate the expertise of involved research groups in four complementary platforms. The Biodiscovery platform allows high-throughput discovery and characterization of yet-uncultured microbes, specifically focusing on fastidious anaerobes. The Modular Bioreactor platform is specifically suitable for investigating sustainable solutions for environmental challenges, such as degradation of (micro)pollutants, sustainable energy generation, and recovery of resources from complex waste streams. The Parallel Bioreactor platform facilitates users to conduct dozens of high-resolution cultivation experiments in bioreactors in parallel for comparative analysis of how process variables affect system development. Finally, the FAIR-Data platform allows for data storage, data extraction and analysis of high-throughput data in a cloud-based infrastructure. The data generated will be FAIR by design, enabling transparent procedures. UNLOCK is open to excellence-driven users from universities, knowledge institutes and industries, placing them in the unique position to conduct research at unmet speed and resolution.

5. **What radar can do for biodiversity monitoring in the sky**
Bart Kranstauer, Bart Hoekstra, Maja Bradarić, Jens van Erp, Ji Qi, Johannes de Groeve, Berend Wijers, Ander Astudillo, Willem Bouten and Judy Shamoun-Baranes
UvA-IBED

Biodiversity is changing at unprecedented rates. Most monitoring of these changes is done on the ground, however organisms like birds, bats and insects use the airspace to move. Therefore it is important to gain quantitative insights where and when these movements take place to investigate changes in abundance and habitat use. Radars are unique tools that continuously monitor the sky and provide insight in these movements. We will present the opportunities for biodiversity monitoring that exist in the Netherlands using this technology. In the Netherlands a uniquely dense network of bird radars as well as meteorological radars exists which covers local to national scales. We show how these radars are used and how they integrate in the European initiatives for radar monitoring within the ARISE and GloBAM projects. We show the research infrastructure that has been developed to facilitate this work. Furthermore, we address the opportunities to integrate these sources of biodiversity information across scales and with other sources of information, to for example investigate responses to fireworks and tidal movements in the Waddensea.

6. **ARISE – Building an infrastructure for species recognition and biodiversity monitoring**
Elaine van Ommen Kloeke
Naturalis Biodiversity Center, ARISE

ARISE (Authoritative and Rapid Identification System for Essential biodiversity information) is a digital infrastructure with a mission to provide semi-automated identification of all multicellular species in the Netherlands and innovate on biodiversity monitoring solutions. By applying DNA barcoding, artificial intelligence for species recognition based on images, sound and radar, and monitoring technology we are able to radically speed up the inventory of life on earth. The infrastructure relies on a species reference database, which brings together new and existing biodiversity information on all multicellular species in the Netherlands. ARISE will be fully open access and data will be organized according to FAIR principles (findable, accessible, interoperable and reusable). We will develop the infrastructure for the whole Dutch research community with financial support from NWO and in partnership with the University of Amsterdam, Westerdijk Institute and the University of Twente. With an AGILE approach our focus is on building iteratively on use cases driven by continuous feedback from external scientists and representatives of species organisations. With ARISE, we will provide the scientific community with the foundation for automated recognition and monitoring of the entire Dutch biodiversity. ARISE will provide a basis for better monitoring to provide policy makers with more reliable information for effective measures.

4d: Coastal ecology

Conveners: Rens Cronau (Radboud University)
Beatriz Marin Diaz (Royal Netherlands Institute of Sea Research,)
Janne Nauta (Groningen University)

1. **Biodegradable artificial reefs enhance food web structure and biodiversity in an intertidal soft-sediment ecosystem**
Janne Nauta, Marjolijn J.A. Christianen, Ralph J.M. Temmink, Gregory S. Fivash, Beatriz Marin-Diaz, Valérie C. Reijers, Emma Penning, Annieke Borst, Karin Didderen, Jannes H.T. Heusinkveld, Maarten Zwarts, Peter M.J.M. Cruijsen, Nadia Hijner, Wouter Lengkeek, Leon P.M. Lamers, Tjisse van der Heide, Tjeerd J. Bouma, Daphne van der Wal, Han Olff, Laura L. Govers
University of Groningen

Reef-forming structures form integral aspects of coastal ecosystems, but are rapidly degrading on a global scale due to human activities and climate change. To mitigate these alarming declines, nature management and conservation science are increasingly relying on the restoration of habitat structuring foundation species (e.g., shellfish reefs, coral reefs). Artificial reefs are a popular restoration measure in submerged ecosystems which are geared towards enhancing benthic communities by mimicking reef-forming species or hard substrates. However, their application in intertidal ecosystems is limited. Therefore, we here aimed to examine biodiversity and food web structure on biodegradable artificial reefs in a soft-sediment intertidal ecosystem. To test whether artificial reefs increase biodiversity and food web complexity compared to surrounding bare soft-sediment flats, we conducted a large-scale restoration experiment using biodegradable artificial reefs, spread across ~650 m and followed for two and halve years on the intertidal flats of the Dutch Wadden Sea. In this experiment, we focused on both small-scale (macrozoobenthic fauna) and large-scale effects (food web networks) and found that artificial reefs 1) changed community composition of macrozoobenthic and increased biodiversity (Pilou's Evenness -58% in 2019) on a small-scale, 2) increased species richness (+63%, S), link density (+12%, L) and the fraction of basal species (+37%) of the food web structure on a large scale compared to the control bare intertidal flat. Therefore, we can conclude that artificial reefs enhance benthic biodiversity, community structure and food web size and complexity in soft-bottom intertidal areas. In this session, we will further elaborate the importance of species interactions for ecosystem functioning through several mechanisms such as: bottom-up and top-down control, the interaction with the abiotic environment and food web interactions in a variety of coastal ecosystems, such as subtidal waters, seagrass meadows and intertidal flats.

2. **Herbivory as a driving force of seagrass species composition and resilience in Caribbean seagrass ecosystems**
Fee O.H. Smulders, Marjolijn .J.A. Christianen, T. S. Becker, Liesbeth .S. Bakker, J. Arie Vonk, Justin E. Campbell
Wageningen University & Research

Global warming and anthropogenic impacts as the introduction of exotic species can alter the local ecological equilibrium of coastal ecosystems, by shifting plant-herbivore and other ecological interactions. Seagrasses are marine plants that provide vital ecosystem services such as carbon storage and coastal protection. We studied how seagrasses respond to shifts in temperature, nutrients, herbivory and seagrass invasion by performing manipulative field experiments in the Caribbean Sea. We found that herbivores can shape plant communities in invaded seagrass ecosystems: on the one hand sea turtles facilitate invasion, while on the other hand diverse fish communities are able to provide biotic resistance, resulting in spatial patterns of seagrass species dominance. Additionally, in a region-wide experiment, (sub)tropical seagrass recovery rates and therefore resilience was found to be mainly driven by a combination of temperature and herbivore grazing pressure, with implications for plant-herbivore equilibria in a warming sea. Overall, our findings increase our understanding of seagrass ecosystems in times of change, leading to management recommendations to improve the management and conservation of these valuable coastal ecosystems.

3. **Benthic biodiversity patterns in the Dutch Wadden Sea**
Oscar Franken, Sander Holthuijsen, Kasper Meijer, Allert Bijleveld, Han Olff, Tjisse van der Heide, Laura Govers
University of Groningen

The Wadden Sea is the largest intertidal mudflat system of the world and is most well-known for its larger species such as birds, seals and fish. However, these species largely depend on the invertebrates, like worms and bivalves, that are living in and on the sediment: the benthic species. Despite their importance, relatively little is known about the distribution of these benthic species, especially in the subtidal parts of the Wadden Sea which are permanently submerged. In this study we use subtidal data from a large-scale sampling campaign within the Waddenmozaïek research program (n = 1325), combined with intertidal data from the NIOZ SIBES sampling campaign (n = 4212). Both sampling campaigns are laid out on a grid with regular intervals (1000m for subtidal and 500m for

intertidal areas), with additional random samples to improve estimates of spatial autocorrelation. The extent of this dataset allows us to map how species richness is distributed throughout the Dutch Wadden Sea in unprecedented resolution. In addition, detailed abiotic data of the Dutch Wadden Sea allows us to link the observed biodiversity patterns to environmental conditions such as depth, sediment characteristics and flow velocity. We hope that visualizing the benthic richness of this unique ecosystem can help management decisions and conservation efforts.

4. Identifying bottlenecks for subtidal eelgrass growth in the Dutch Wadden Sea

Katrin Rehlmeyer, Oscar Franken, Tjisse van der Heide, Sander Holthuijsen, Han Olff, Wouter Lengkeek, Karin Didderen, Laura L. Govers
University of Groningen

Extensive subtidal eelgrass (Zostera marina) meadows grew in the Western Dutch Wadden Sea. Since the 1930s, because of the wasting disease and construction of the Enclosure Dam, the population vanished completely. Seagrass shoots induce positive feedback by reduced hydrodynamic forcing, while dense root mats increase sediment stability. This leads to ameliorated conditions, also benefitting other species. In a system without seagrass, self-facilitation is lacking. To identify the most important bottlenecks limiting seagrass growth, we used artificial structures inducing similar feedback. In a full-factorial field experiment, we tested how buried structures and sandbag walls influenced survival and persistence of transplantation units. Shoots were tied to anchoring devices to prevent washing-out. A pronounced edge-effect of the walls reversed their facilitating effect and caused erosion and sedimentation, leading to less survival and persistence. Sediment stabilizing structures increased survival significantly. After one month, more than 90% of the transplant units were still present, proving that the transplantation technique works in the Dutch Wadden Sea. Ultimately, after three month, all seagrass shoots died. Hypotheses for the die-off are high salinity differences between harvest site and transplantation site, and/and poor light conditions. These particular bottlenecks should be further investigated in a lab experiment.

5. Seagrass-ragworm interaction reducing seagrass survival by tube construction is mitigated by a dual-protection interaction with epiphyte grazers

Rens J. T. Cronau, Yvet Telgenkamp, Jimmy de Fouw, Marieke M. van Katwijk, Tjeerd J. Bouma, Leon P. M. Lamers, Tjisse van der Heide
Radboud University Nijmegen

Coastal ecosystems are controlled by trophic interactions, regulating the system through bottom-up (resource-driven) and top-down (consumer-driven) forcing, and non-trophic interactions. Anthropogenic disturbances globally disrupt these interactions, leading to degradation of the system's foundation species. Within these degraded ecosystems, new interactions can become dominant drivers. In saltwater Lake Grevelingen, once harbouring seagrass which was lost to anthropogenic disturbances, seagrass restoration success was adversely affected by a new non-trophic interaction between two common species: *Zostera marina* and *Platynereis dumerilii*. This ragworm species constructs dwelling tubes between seagrass leaves, gluing them together and entangling them in the process. Mesograzers were near-absent in Lake Grevelingen. We introduced the grazer *Littorina littorea* in a field experiment, and performed a full factorial lab experiment applying Littorina, Platynereis and nutrient treatments. Our results show that top-down control by *L. littorea* protected seagrass through two pathways: (1) mitigating bottom-up regulated epiphyte growth by trophic top-down forcing and (2) hampering the non-trophic interaction between *Z. marina* and *P. dumerilii*. The latter interaction significantly influenced seagrass fitness. With coastal ecosystems under pressure globally, these interactions emphasise the importance of top-down forcing and prove that a healthy mesograzer population is even more important than previously thought.

6. Establishment of clonally expanding cordgrass: Better safe than sorry

Clea N. van de Ven, Carlijn Lammers, Valérie C. Reijers, Tjisse van der Heide
Royal Netherlands Institute for Sea Research / University of Groningen

Vegetated coastal ecosystems such as salt marshes and seagrass meadows occur at the land-sea interface. The ecological functioning and services these ecosystems provide critically depend on self-reinforcing interactions between biota and geomorphology. Vegetation engineers landforms to its own benefit following positive density-dependent relationships. However, in aquatic systems turbulence and drag around establishing plants lead to a so-called establishment threshold, especially in exposed environments. Although it is well known that plant traits affect ecosystem engineering, and hence their own survival, it remains unknown how spatial shoot organization controls potential establishment thresholds and engineering strength. To explore how shoot placement strategies of establishing cordgrass (*Spartina anglica*) patches are affected by prevailing environmental conditions, we first determined aboveground shoot patterns of 90 clonally connected cordgrass plants at 18 sites along the NW European coast covering both exposed and sheltered sites. Second, we studied the influence of the observed shoot pattern on sediment feedbacks in exposed and sheltered hydrodynamic conditions in a

field experiment. Contrary to our expectations, we show that despite widely varying environmental conditions, the shoot organization of establishing *S. anglica* patches was highly consistent. The observed clustered growth pattern minimizes the biophysical interaction and gears towards an early stress avoidance strategy.

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	Thiago Almeida Bueno	What almost 40 years of monitoring reveals about the dynamics and sustainability of a conservation unit in the Atlantic Forest
2	Patrick Baan	Intraspecific variation in germinaton and seed coat structure in a Fabaceae tree
3	Maureen Baars	Functional properties of the avian preen gland microbiome: chemosignalling and antimicrobial potentials
4	Anne Beaulieu	Database interfaces, knowledge infrastructures and conservation policy: A case study of Movebank
5	Dieke Boezen	The effect of mixed infection on the accumulation of a multipartite plant virus
6	Stijn van den Bergh	Compost as a vector for the introduction of methanotrophic bacteria in agricultural soils: effects on atmospheric methane uptake
7	Caitlin Black	The Amsterdam Rat Project: Systematically monitoring Amsterdam's brown rat populations using a range of innovative methods
8	Gabriella Bishop	Hedgerows have contrasting effects on pollinators and natural enemies and limited spillover effects on apple production
9	Kerstin Bouma	How do water level fluctuations benefit wetland birds?
10	Hannah Broeckx	Moth-Predator Relations in the Spotlight. Does artificial light displace the balance?
11	Nelleke Buitendijk	More grazing, more damage? Factors influencing the impact of geese on agricultural grasslands
12	Isabelle Buyens	How facilitation by an unpalatable rush affects the invasive grass Elytrigia atherica in a salt marsh
13	Meijun Chen	Comprehensive assessment of the contribution of Exogenous and Endogenous nutrients sources to the seasonal eutrophication of Erhai Lake using PCLake + model

14	Gabriel Charvalakis	Phototactic responses of insects to artificial light at night”.
15	Marieke de Cock	The relation between urban greenspace, the abundance of wild rats, and their zoonotic pathogen prevalence and diversity
16	Caterina Coral	A North Sea banquet: unravelling the effect of offshore reefs on food web structure
17	Maya Daumal	Biodiversity of macroinvertebrates in the Grensmaas Valley
18	Menghui Dong	Microscale assembly of bacterial community among soil aggregates impacts tomato Ralsotnia wilt suppression
19	Helena Donner	Quenching autofluorescence in Aphis fabae
20	Eileen Enderle	The impact of extreme summer drought on grassland plant communities
21	Eleanor Greenway	Population dynamics of elasmobranchs in the North Sea
22	Xu Han	Grazing changes the soil micro-food-web, who drives it?
23	Fangbin Hou	Drought increases root-exudate-induced soil respiration across 17 common grassland species
24	Miao He	Cumulative nitrogen addition alters grassland overyielding by shifting the contribution of complementarity and selection effects
25	Junxi Hu	Nitrogen addition to soil affects microbial carbon use efficiency: Meta-analysis of similarities and differences in 13C and 18O approaches
26	Inger de Jonge	Metamicrobiome-driven homeostasis of nutrient recycling
27	Daan Kinsbergen	Pattern and process in biodiversity recovery after exclusion of large herbivore grazing
28	Jip Koene	Light Pollution affects Local Moth Community Composition
29	Johan van de Koppel	Visualising adaptive ecosystems
30	Anne Krediet	Earthworms and AI
31	Saskia Kühn	Underwater habitat soundscapes of the Wadden Sea

32	Sander Buddendorf	Understanding the urban bat: the effects of artificial light at night on activity and bat-insect interactions
33	Anne Kupczok	The abundance and evolution of auxiliary metabolic genes in virulent bacteriophages
34	Klara Leander Oh	Biodiversity offsets as a potential tool for pollinator conservation
35	Hugo Langezaal	Biodiversity enhancement in the Dutch Flower Bulb Region – Wasteland or Wilderness in an agricultural landscape?
36	Yike Li	Decreasing greenhouse gas emissions from surface waters by climate-smart water management
37	Hans Linssen	Using GPS tracking to determine spatial bias in resighting data
38	Loéva Martin-Podevin	Does fishway passage success depend on individual phenotype? A study in three-spined sticklebacks (Gasterosteus aculeatus)
39	Kyle Mason-Jones	Nematodes facilitate soil bacteriophage dispersal
40	Ian McFadden	Global plant-frugivore trait matching is shaped by climate and biogeographic history
41	Calvin Mehl	A network of small mammal pathogen ecology research
42	Zulin Mei	High evenness and efficient species of natural enemy drive aphid suppression
43	Kasper Meijer	Bedform variability mapping through single beam echo sounding in the Dutch Wadden Sea
44	Nokuthula Mhlongo	Deviation in mobility patterns as an early indicator of lameness in dairy cows using sensor technology
45	Janne Nauta	Artificial reefs enhance food web structure and biodiversity in an intertidal soft-sediment ecosystem
46	Azkia Nurfikari	Closing the loop: use of insect residual streams to improve soil health
47	Omotola Odetayo	Effect of grassland species composition on functionally different soil organic carbon
48	Bram Parmentier	The spatiotemporal abundance, distribution, and energy content of small bottom prey fish species, with a main focus on sandeel species (Ammodytidae), in the southern North Sea.
49	Anaïs Paturle	Fast and Furious sticklebacks: testing the validity of the pace-of-life syndrome hypothesis

50	Katrin Rehlmeyer	Identifying Bottlenecks of Subtidal Eelgrass Growth in the Dutch Wadden Sea
51	Kees Schreven	Extreme and rapid range expansion by Arctic geese: coping with climate change?
52	Lotte Staal	Sexual dimorphic UV reflectance on the wings of Boloria pales
53	Ivanka Spruijt	Shedding artificial light on nocturnal insect pollination interactions
54	Sven Teurlincx	Flipping Lakes: Explaining concepts of catchment-scale water management through a serious game.
55	Duygu Tolunay	The interaction of microbial exoenzymes and phenolic compounds in Dutch peatlands
56	Ingrid Tulp	Swimway the Netherlands, 2020-2024 program: from knowledge to management
57	Archontoula Valsamidou	Peatland patterns development: Modeling coastal peatlands facing sea-level rise
58	Bin Tuo	Facilitation: how wood-boring beetles drive the trophic diversity of secondary decomposers
59	Joeri Zwerts	"FSC-certified forestry benefits large and critically endangered wildlife compared to non-FSC
60	Maryann Watson	Underwater habitat soundscapes of the Wadden Sea
61	Rik Veldhuis	The effects of nitrogen deposition and mycorrhizal fungi on the regeneration of Juniperus communis
62	Ellen Weerman	Climate-robust Landscapes: connecting agriculture and nature
63	Jasper Wubs	SubTerra Incognita: Putting soil biodiversity in context
64	Elke Wenting	Functional differences in scavenger communities and the speed of carcass decomposition
65	Hao Yu	Algal bloom study in Taihu Lake using big data and deep learning techniques
66	Shudong Zhang	Experimental evidence that leaf litter decomposability and flammability are decoupled across species
67	Amanda Augusta Fernandez	Determining the socio-ecological factors that influence land use decisions in tropical agricultural systems in the Atlantic Forest region, Brazil

68	Hui Jin	The Marker Wadden improved phytoplankton quantity and quality with a cascading effect on zooplankton production
69	Lisa Sánchez	On the European bison's rewilding hooves: how to visualize it?
70	Esther Swankhuisen	The impacts of (feral) cats on meadow bird populations
71	Sterre Witte	Designing habitat complexity; studying the effect if habitat complexity on epibenthic communities using 3D printed substrate
72	Sophie van Rijssel	Linking soil communities to arable management practices and soil functions using network analysis

NERN Best Poster Award
Voting instructions

The Netherlands Ecological Research Network will award prizes for the best poster presentations of the NAEM meeting. As usual, there will be a first (€ 300,-), second (€ 200,-) and third (€ 100,-) prize. The award ceremony will be during the closing session on Wednesday afternoon.

Who is eligible to win this prize?
All participants of NAEM that are presenting a poster during the meeting are eligible to take part in the competition. Note, however, that you can only participate if you will be present during the closing ceremony on Wednesday or when you have informed us about a representative that will be present during the ceremony to collect your prize.

Evaluation criteria
All participants of the NAEM meeting can nominate their favourite poster. Evaluation of the posters should be based on the quality of the content/impact, novelty, appeal, and clarity.

Evaluation / Selection procedure
The NAEM audience can cast their vote for the best poster. One can only vote once during the two-day NAEM meeting. A special website / app will be used for this. The procedure is as follows:

- Scan the QR code below, type the following link in your internet browser of your laptop, tablet, or smartphone: **live.voxvote.com**, or download the **"VoxVote Live Voting App**" for Android or IOS in the App Store / Play Store and use pin code **155564**
- to enter the NAEM voting site.
- Vote for the poster that, in your opinion, is the best of all the posters that are on display during the NAEM meeting. **Please use the number from the poster list in the reader**.
- You can cast your vote at any time during the meeting, up to Wednesday afternoon 15:00 hrs (the end of the second poster session). After this moment the voting site will be closed.
- The total number of votes for each poster will be calculated and this will lead to a top 3.

SCAN THE QR CODE ABOVE TO CAST YOUR VOTE

List of participants

	Name	Institute / University	E-mail address
1	Wouter Addink	Naturalis Biodiversity Center	wouter.addink@naturalis.nl
2	Rien Aerts	Vrije Universiteit Amsterdam	m.a.p.a.aerts@vu.nl
3	Rob Alkemade	PBL Netherlands Environmental Assessment Agency	rob.alkemade@pbl.nl
4	Thiago Almeida Bueno	Wageningen University & Research	thiago.almeida.bueno@usp.br
5	Cassandra van Altena	Netherlands Institute of Ecology	c.vanaltena@nioo.knaw.nl
6	Adriana Alzate Vallejo	German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig	adria.alzate@gmail.com
7	Francisca Araújo e Sá Virtuoso	Wageningen University & Research	francisca.araujoesavirtuoso@wur.nl
8	Amanda Augusta Fernandes	University of São Paulo (USP)	aafer18@usp.br
9	Patrick Baan	University of Groningen	p.baan@student.rug.nl
10	Maureen Baars	University of Groningen	i.m.baars@rug.nl
11	Liesbeth Bakker	Netherlands Institute of Ecology	l.bakker@nioo.knaw.nl
12	Swarnendu Banerjee	Utrecht University	s.banerjee@uu.nl
13	Olaf Bánki	Naturalis Biodiversity Center	olaf.banki@naturalis.nl
14	Niek Barmentlo	Vrije Universiteit Amsterdam	Niekbarmentlo@gmail.com
15	Anne Beaulieu	University of Groningen	j.a.beaulieu@rug.nl
16	Mariska Beekman	Wageningen University & Research	mariska.beekman@wur.nl
17	Inka Bentum	Wageningen University & Research	inka.bentum@wur.nl
18	Merlijn van den Berg	Louis Bolk Institute	m.vandenberg@louisbolk.nl
19	Stijn van den Bergh	Netherlands Institute of Ecology	s.vandenbergh@nioo.knaw.nl
20	Felix Bianchi	Wageningen University & Research	felix.bianchi@wur.nl
21	Allert Bijleveld	Royal Netherlands Institute for Sea Research	allert.bijleveld@nioz.nl
22	Wender Bil	University of Groningen	w.bil@rug.nl
23	Karin Bilo	SeaQurrent	karin.bilo@seaqurrent.com
24	Gabriella Bishop	Wageningen University & Research	gabriella.bishop@wur.nl
25	Caitlin Black	University of Amsterdam	c.e.black@uva.nl
26	Titus Boerma	University of Leiden	tnboerma@gmail.com
27	Dieke Boezen	Netherlands Institute of Ecology	d.boezen@nioo.knaw.nl
28	Stef Bokhorst	Vrije Universiteit Amsterdam	s.f.bokhorst@vu.nl
29	Frans Bongers	Wageningen University & Research	frans.bongers@wur.nl
30	Chiel Boom	University of Amsterdam	c.boom@nioo.knaw.nl
31	Mirte Bosse	Wageningen University & Research	mirte.bosse@wur.nl
32	Kerstin Bouma	Netherlands Institute of Ecology	k.bouma@nioo.knaw.nl
33	Meike Bouwman	Wageningen University & Research	meike.bouwman@wur.nl
34	Bob Brederveld	Witteveen & Bos	bob.brederveld@witteveenbos.com
35	Hannah Broeckx	University of Amsterdam	h.broeckx@uva.nl
36	Marjolein Bruijning	Princeton University	mbruijning@princeton.edu
37	Luc De Bruyn	Research Institute for Nature and Forest (INBO)	luc.debruyn@inbo.be
38	Sander Buddendorf	Netherlands Institute of Ecology	s.buddendorf@nioo.knaw.nl
39	Nelleke Buitendijk	Netherlands Institute of Ecology	n.buitendijk@nioo.knaw.nl
40	Emily Burdfield-Steel	University of Amsterdam	e.r.burdfieldsteel@uva.nl
41	Isabelle Buyens	University of Groningen	I.P.R.Buyens@rug.nl
42	Evelien Castrop	University of Leiden	evelien.castrop@cml.leidenuniv.nl
43	Gabriel Charvalakis	Netherlands Institute of Ecology	G.Charvalakis@nioo.knaw.nl
44	Meijun Chen	Wageningen University & Research	meijun.chen@wur.nl
45	Marjolijn Christianen	Wageningen University & Research	marjolijn.christianen@wur.nl
46	Marieke de Cock	RIVM	marieke.de.cock@rivm.nl
47	Caterina Coral	Royal Netherlands Institute for Sea Research	caterina.coral@nioz.nl

	Name	Institute / University	E-mail address
48	Loreta Cornacchia	Royal Netherlands Institute for Sea Research	loreta.cornacchia@nioz.nl
49	Lydia Cornu	Wageningen University & Research	lydia.cornu@wur.nl
50	Rens Cronau	Radboud University Nijmegen	rens.cronau@ru.nl
51	Maya Daumal	Maastricht University + WUR	m.daumal@maastrichtuniversity.nl
52	Jonathan De Long	Louis Bolk Institute	j.delong@louisbolk.nl
53	Jacintha van Dijk	Sovon Vogelonderzoek Nederland	jacintha.vandijk@sovon.nl
54	Menghui Dong	Utrecht University	m.dong@uu.nl
55	Helena Donner	Wageningen University & Research	helena.donner@wur.nl
56	Eva Drukker	Wageningen University & Research	eva.drukker@wur.nl
57	Sjoerd Duijns	Sovon vogelonderzoek Nederland	sjoerd.duijns@sovon.nl
58	Jena Edwards	Royal Netherlands Institute for Sea Research	jena.edwards@nioz.nl
59	Eileen Enderle	University of Amsterdam	e.enderle@uva.nl
60	Bruno J. Ens	Sovon Dutch Centre for Field Ornithology	bruno.ens@sovon.nl
61	Jens van Erp	University of Amsterdam	j.a.vanerp@uva.nl
62	Alexandra Evans	KU Leuven	alexandra.evans@kuleuven.be
63	Nicky Faber	Wageningen University & Research	nicky.faber@wur.nl
64	Lena Faller	Netherlands Institute of Ecology	L.Faller@nioo.knaw.nl
65	Thijs Fijen	Wageningen University & Research	thijs.fijen@wur.nl
66	Ron Fouchier	Erasmus MC	r.fouchier@erasmusmc.nl
67	Jimmy de Fouw	Radboud University Nijmegen	j.defouw@science.ru.nl
68	Oscar Franken	University of Groningen	o.franken@rug.nl
69	Thijs Frenken	HAS University of Applied Sciences	T.Frenken@has.nl
70	Carol Garzon-Lopez	University of Groningen	c.x.garzon.lopez@rug.nl
71	Simone Gasque	Wageningen University & Research	simone.gasque@wur.nl
72	Gijs Gerrits	Wageningen University & Research	gijs.gerrits@wur.nl
73	Jan van Gils	Royal Netherlands Institute for Sea Research	Jan.van.Gils@nioz.nl
74	Steven de Goede	Netherlands Institute of Ecology	S.deGoede@nioo.knaw.nl
75	William Gosling	University of Amsterdam	w.d.gosling@uva.nl
76	Laura Govers	University of Groningen	l.l.govers@rug.nl
77	Eleanor Greenway	Wageningen University & Research	eleanor.greenway@wur.nl
78	Ben Griffioen	Wageningen Marine Research	ben.griffioen@wur.nl
79	Thomas Groen	University of Twente	t.a.groen@utwente.nl
80	Alena Gsell	WFSR DLO onderzoeker	alena.gsell@wur.nl
81	Thomas Hackl	University of Groningen	t.hackl@rug.nl
82	Martijn Hammers	Aeres University of Applied Sciences	m.hammers@aeres.nl
83	Xu Han	Wageningen University & Research	x.han@nioo.knaw.nl
84	Emilia Hannula	University of Leiden	s.e.hannula@cml.leidenuniv.nl
85	Paula Harkes	Wageningen University & Research	paula.harkes@gmail.com
86	Miao He	Utrecht University	m.he@students.uu.nl
87	Tijsse van der Heide	University of Groningen	t.van.der.heide@rug.nl
88	Amber Heijboer	Netherlands Institute of Ecology	a.heijboer@nioo.knaw.nl
89	Britte M Heijink	University of Amsterdam	b.m.heijink@uva.nl
90	Robin Heinen	Technische Universität München	robin.heinen@tum.de
91	Miriam van Heist	Wageningen University & Research	miriam.vanheist@wur.nl
92	Marjon Hellegers	PBL Netherlands Environmental Assessment Agency	marjon.hellegers@pbl.nl
93	Lia Hemerik	Wageningen University & Research	lia.hemerik@wur.nl
94	Lisanne Hendriks	Radboud University Nijmegen	lisanne.hendriks@ru.nl
95	Geerten Hengeveld	Wageningen University & Research	Geerten.Hengeveld@wur.nl
96	Claire Hermans	Netherlands Institute of Ecology	c.hermans@nioo.knaw.nl
97	Eric Higgs	University of Victoria	ehiggs@uvic.ca
98	Nadia Hijner	University of Groningen	nadia_hijner@hotmail.com
99	Anouschka Hof	Wageningen University & Research	anouschka.hof@wur.nl
100	Grant Hopcraft	University of Glasgow	grant.hopcraft@glasgow.ac.uk
101	Fangbin Hou	University of Amsterdam	f.hou@uva.nl

	Name	Institute / University	E-mail address
102	Jie Hu	University of Rennes 1	jie.hu@univ-rennes1.fr
103	Junxi Hu	Vrije Universiteit Amsterdam	junxihu@stu.sicau.edu.cn
104	Floor Hugenholtz	NWO	f.hugenholtz@nwo.nl
105	Milou Huizinga	Vrije Universiteit Amsterdam	milou.huizinga@gmail.com
106	Jurrian van Irsel	Netherlands Institute of Ecology	j.vanirsel@nioo.knaw.nl
107	Monique de Jager	Netherlands Institute of Ecology	m.dejager@nioo.knaw.nl
108	Rebecca James	Wageningen University & Research	rebecca.james@ulb.be
109	Laura Jaramillo	Wageningen University & Research	ljaramillo90@outlook.com
110	Theo Jetten	PE&RC Office	theo.jetten@wur.nl
111	Mengru Jia	University of Amsterdam	m.jia@uva.nl
112	Hui Jin	Netherlands Institute of Ecology	H.Jin@nioo.knaw.nl
113	Marcelle Johnson	Netherlands Institute of Ecology	M.Johnson@nioo.knaw.nl
114	Inger de Jonge	Vrije Universiteit Amsterdam	ingerdejonge@gmail.com
115	Sannimari Käärmelahti	Radboud University Nijmegen	s.kaarmelahti@science.ru.nl
116	Dharani Kamalachandran	Utrecht University	d.kamalachandran@uu.nl
117	Bram Kamps	Wageningen University & Research	bram.kamps@wur.nl
118	Julia Karagicheva	University of Amsterdam	jkaraj@gmail.com
119	Rosemarie Kentie	University of Amsterdam	r.kentie@uva.nl
120	Calyne Khamila	University of Leiden	s.j.norder@uu.nl
121	Daan Kinsbergen	University of Amsterdam	d.t.p.kinsbergen@uva.nl
122	Dennis Knuth	Wageningen University & Research	dennis.knuth@wur.nl
123	Jip Koene	University of Amsterdam	jipkoenemailen@gmail.com
124	Jazz Kok	Wageningen University & Research	jazz.kok@wur.nl
125	Johan van de Koppel	Royal Netherlands Institute for Sea Research	johan.van.de.koppel@nioz.nl
126	Elizabeth Koppenaal	FLORON	koppenaal@floron.nl
127	Megan Korte	University of Groningen	m.k.korte@rug.nl
128	Sarian Kosten	Radboud University Nijmegen	sarian.kosten@ru.nl
129	Martine Kox	Deltares	martinekox@gmail.com
130	Lilith Kramer	Netherlands Institute of Ecology	L.Kramer@nioo.knaw.nl
131	Bart Kranstauber	University of Amsterdam	b.kranstauber@uva.nl
132	Anne Krediet	Vrije Universiteit Amsterdam	a.f.krediet@vu.nl
133	Hans de Kroon	Radboud University Nijmegen	hans.dekroon@ru.nl
134	Saskia Kühn	Kiel University	kuehn@ftz-west.uni-kiel.de
135	Anne Kupczok	Wageningen University & Research	anne.kupczok@wur.nl
136	Thomas Lameris	Royal Netherlands Institute for Sea Research	thomaslameris@gmail.com
137	Carlijn Lammers	Royal Netherlands Institute for Sea Research	carlijn.lammers@nioz.nl
138	Frank van Langevelde	Wageningen University & Research	frank.vanlangevelde@wur.nl
139	Hugo Langezaal	Netherlands Institute of Ecology	h.langezaal@nioo.knaw.nl
140	Klara Leander Oh	Wageningen University & Research	klara.leanderoh@wur.nl
141	Ana Shein Lee Diaz	Netherlands Institute of Ecology	A.LeeDiaz@nioo.knaw.nl
142	Joep de Leeuw	Wageningen Marine Research	joep.deleeuw@wur.nl
143	Casper van Leeuwen	Netherlands Institute of Ecology	c.vanleeuwen@nioo.knaw.nl
144	Justine Lejoly	Netherlands Institute of Ecology	j.lejoly@nioo.knaw.nl
145	Yike Li	Netherlands Institute of Ecology	y.li@nioo.knaw.nl
146	Yuhong Li	University of Groningen	yuhong.li@rug.nl
147	Hans Linssen	University of Amsterdam	h.j.linssen@uva.nl
148	Iryna Litovska	Wageningen University & Research	iryna.lit@gmail.com
149	Tamar Lok	Royal Netherlands Institute for Sea Research	tamar.lok@nioz.nl
150	Janneke Van der Loop	Radboud University Nijmegen	j.vanderloop@science.ru.nl
151	Martijn Los	NWO	m.los@nwo.nl
152	Gert van Maanen	Netherlands Institute for Biology	maanen@bionieuws.nl
153	Miriam Maas	RIVM	miriam.maas@rivm.nl
154	Margot Maathuis	Wageningen University & Research	margot.maathuis@wur.nl
155	Loéva Martin-Podevin	University of Groningen	l.l.martin-podevin@student.rug.nl

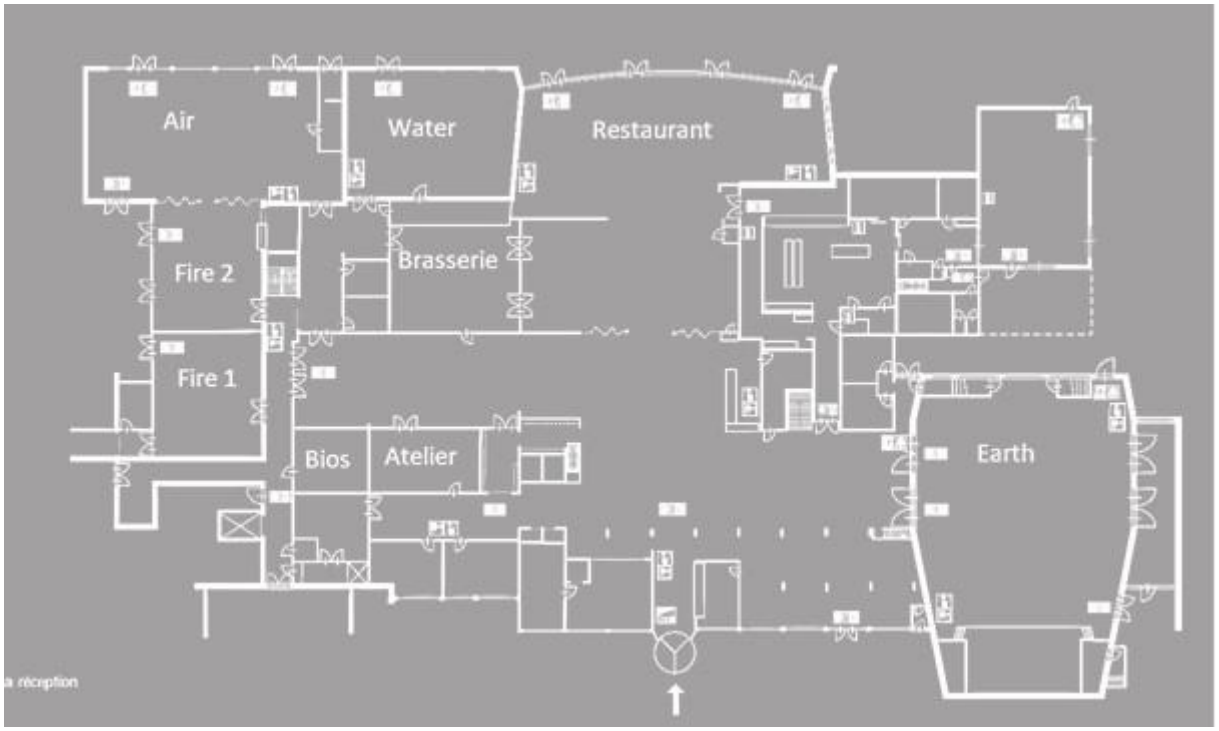
	Name	Institute / University	E-mail address
156	Kyle Mason-Jones	Netherlands Institute of Ecology	k.masonjones@nioo.knaw.nl
157	Tomonari Matsuo	Wageningen University & Research	tomonari.matsuo@wur.nl
158	Jonas Mauch	IGB Berlin	jonas.mauch@igb-berlin.de
159	Ian McFadden	University of Amsterdam	ian.mcfadden@uva.nl
160	Suzanne McGowan	Netherlands Institute of Ecology	s.mcgowan@nioo.knaw.nl
161	Calvin Mehl	Friedrich-Loeffler Institute	Calvin.Mehl@fli.de
162	Zulin Mei	Wageningen University & Research	zulin.mei@wur.nl
163	Kasper Meijer	University of Groningen	k.j.meijer@rug.nl
164	Eva Meijers	Wageningen University & Research	eva.meijers@wur.nl
165	Luis Fernando Merloti	Wageningen University & Research	luisfernando.merloti@wur.nl
166	Nokuthula Mhlongo	Wageningen University & Research	nokuthulalorraine.mhlongo@wur.nl
167	Bjorn Mols	University of Groningen	B.mols@rug.nl
168	Wolf Mooij	Netherlands Institute of Ecology	w.mooij@nioo.knaw.nl
169	Elly Morriën	University of Amsterdam	w.e.morrien@uva.nl
170	Rodrigo Muñoz	Wageningen University & Research	rodrigo.munozaviles@wur.nl
171	Leo Nagelkerke	Wageningen University & Research	leo.nagelkerke@wur.nl
172	Andreea Nanu	University of Leiden	a.nanu@cml.leidenuniv.nl
173	Majoi Nascimento	University of Amsterdam	m.denovaesnascimento@uva.nl
174	Janne Nauta	University of Groningen	janne.nauta@rug.nl
175	Marion Nicolaus	University of Groningen	nicolaus.marion@gmail.com
176	Evy de Nijs	University of Amsterdam	e.a.denijs@uva.nl
177	Bart Nolet	Netherlands Institute of Ecology	b.nolet@nioo.knaw.nl
178	Sietze Norder	Utrecht University	s.j.norder@uu.nl
179	Azkia Nurfikari	Netherlands Institute of Ecology	a.nurfi@nioo.knaw.nl
180	Baudewijn Odé	FLORON Plant Conservation Netherlands	ode@floron.nl
181	Omotola Odetayo	Wageningen University & Research	omotola.odetayo@wur.nl
182	Lina Marcela Ojeda Prieto	Tecnical University of Munich	lina.ojeda@tum.de
183	Han Olff	University of Groningen	h.olff@rug.nl
184	Elaine van Ommen Kloeke	Naturalis Biodiversity Center	elaine.vanommenkloeke@naturalis.nl
185	Gerard Oostermeijer	University of Amsterdam	j.g.b.oostermeijer@uva.nl
186	Janne Ouwehand	University of Groningen	janneouwehand@gmail.com
187	José van Paassen	Wageningen University & Research	jose.vanpaassen@wur.nl
188	Kaixuan Pan	University of Leiden	k.pan@cml.leidenuniv.nl
189	Bram Parmentier	Royal Netherlands Institute for Sea Research	bram.parmentier@nioz.nl
190	Anaïs Paturle	University of Groningen	a.c.s.p.paturle@student.rug.nl
191	Emma Penning	Royal Netherlands Institute for Sea Research	emma.penning@nioz.nl
192	Helen Phillips	Netherlands Institute of Ecology	h.phillips@nioo.knaw.nl
193	Gonçalo Piedade	Royal Netherlands Institute for Sea Research	goncalo.piedade@nioz.nl
194	Marjolein Poelman	Antea Group	marjoleinpoelman@gmail.com
195	Suzanne Poiesz	Netherlands Institute of Ecology	suzanne.poiesz@nioz.nl
196	Lourens Poorter	Wageningen University & Research	lourens.poorter@wur.nl
197	Sanne Poppeliers	Utrecht University	s.w.m.poppeliers@uu.nl
198	Leo Posthuma	RIVM	leo.posthuma@rivm.nl
199	Yanning Qiu	Wageningen University & Research	yanning.qiu@wur.nl
200	Mark Rademaker	Royal Netherlands Institute for Sea Research	mark.rademaker@nioz.nl
201	Niels Raes	Naturalis Biodiversity Center	nlbif@naturalis.nl
202	Eldar Rakhimberdiev	University of Amsterdam	eldar.rakhimberdiev@uva.nl
203	Aparajitha Ramesh	University of Groningen	ocelotapu@gmail.com
204	Shumaila Rasool	Netherlands Institute of Ecology	S.Rasool@nioo.knaw.nl
205	Katrin Rehlmeyer	University of Groningen	k.rehlmeyer@rug.nl
206	Max Rietkerk	Utrecht University	m.g.rietkerk@uu.nl
207	Kenneth Rijsdijk	University of Amsterdam	k.f.rijsdijk@uva.nl
208	Sophie van Rijssel	Netherlands Institute of Ecology	s.vanrijssel@nioo.knaw.nl
209	Marianne Rijtma	Wageningen University & Research	marianne.rijtma@wur.nl

	Name	Institute / University	E-mail address
210	Oriana Sanchez Mahehca	Technical University Munich	oriana.sanchez@tum.de
211	Lisa Sánchez-Aguilar	University of Groningen	lsanchez@tdluciernagas.com
212	Masha van der Sande	Wageningen University & Research	masha.vandersande@wur.nl
213	Pedro Santos Neves	University of Groningen	p.m.santos.neves@rug.nl
214	Peter Schaap	UNLOCK consortium	peter.schaap@wur.nl
215	Luuk Scholten	Wageningen University & Research	luuk.scholten@wur.nl
216	Kees Schreven	Netherlands Institute of Ecology	k.schreven@nioo.knaw.nl
217	Matteo Sciumbata	Vrije Universiteit Amsterdam	matteo.sciumbata@gmail.com
218	Sanja Selakovic	Wageningen University & Research	sanjakojasanja@gmail.com
219	Lilia Serrano Grijalva	Netherlands Institute of Ecology	l.serrano@nioo.knaw.nl
220	Judy Shamoun-Baranes	University of Amsterdam	j.z.shamoun-baranes@uva.nl
221	Xianhui Shi	Netherlands Institute of Ecology	x.shi@nioo.knaw.nl
222	Yali Si	University of Leiden	y.si@cml.leidenuniv.nl
223	Chris Smit	University of Groningen	c.smit@rug.nl
224	Fee Smulders	Wageningen University & Research	feesmulders@gmail.com
225	Geert de Snoo	Netherlands Institute of Ecology	g.deSnoo@nioo.knaw.nl
226	Floor Soudijn	Wageningen University & Research	floor.soudijn@wur.nl
227	Annemarieke Spitzen	RAVON	a.spitzen@ravon.nl
228	Ivanka Spruijt	University of Leiden	i.spruijt@cml.leidenuniv.nl
229	Lotte Staal	University of Amsterdam	staal.lotte@gmail.com
230	Twan Stoffers	Wageningen University & Research	twan.stoffers@wur.nl
231	Quinten Struik	Radboud University Nijmegen	quinten.struik2@ru.nl
232	Lennart Suselbeek	Wildlife Monitoring Solutions	lennart@wildlifemonitoringsolutions.nl
233	Esther Swankhuisen	University of Groningen	e.swankhuisen@rug.nl
234	Constant Swinkels	Radboud University Nijmegen	constant.swinkels@ru.nl
235	Chloé Tavernier	Wageningen University & Research	chloe.tavernier@wur.nl
236	Ralph Temmink	Utrecht University	r.j.m.temmink@uu.nl
237	Vicky Temperton	Leuphana University Lüneburg	temperto@leuphana.de
238	Sven Teurlincx	Netherlands Institute of Ecology	s.teurlincx@nioo.knaw.nl
239	Duygu Tolunay	Utrecht University	d.tolunay@uu.nl
240	Barbara Tomotani	Netherlands Institute of Ecology	b.tomotani@nioo.knaw.nl
241	Marlee Tucker	Radboud University Nijmegen	marlee.tucker@ru.nl
242	Ingrid Tulp	Wageningen Marine Research	ingrid.tulp@wur.nl
243	Bin Tuo	Vrije Universiteit Amsterdam	b.tuo@vu.nl
244	Luis Valente	Naturalis Biodiversity Center	luis.valente@naturalis.nl
245	Archontoula Valsamidou	Royal Netherlands Institute for Sea Research	archontoula.valsamidou@gmail.com
246	Frederik Van Daele	KU Leuven	frederik.vandaele@kuleuven.be
247	Judith van der Knaap	Radboud University Nijmegen	judith.vanderknaap@ru.nl
248	Kees van Oers	Netherlands Institute of Ecology	k.vanoers@nioo.knaw.nl
249	Annemarie van Wezel	University of Amsterdam	a.p.vanwezel@uva.nl
250	Ciska Veen	Netherlands Institute of Ecology	c.veen@nioo.knaw.nl
251	Laura van Veenhuisen	Stichting Bargerveen/RU	l.vanveenhuisen@science.ru.nl
252	Henk van der Veer	Netherlands Institute of Ecology	henk.van.der.veer@nioz.nl
253	Rik Veldhuis	University of Groningen	e.r.veldhuis@rug.nl
254	Mandy Velthuis	Radboud University Nijmegen	mandy.velthuis@ru.nl
255	Clea van de Ven	Royal Netherlands Institute for Sea Research	clea.van.de.ven@nioz.nl
256	Annelies Veraart	Radboud University Nijmegen	a.veraart@science.ru.nl
257	Dylan Verheul	Observation.org	office@observation.org
258	Dylan Verheul	Observation International	dylan@observation.org
259	Jacqueline Verhoef	NERN	jacqueline.verhoef@wur.nl
260	Mo Verhoeven	Netherlands Institute of Ecology	m.verhoeven@nioo.knaw.nl
261	Claudius van de Vijver	NERN Office	claudius.vandevijver@wur.nl
262	Nacho Villar	Netherlands Institute of Ecology	nachoprad@gmail.com
263	Eric Visser	Radboud University Nijmegen	eric.visser@science.ru.nl

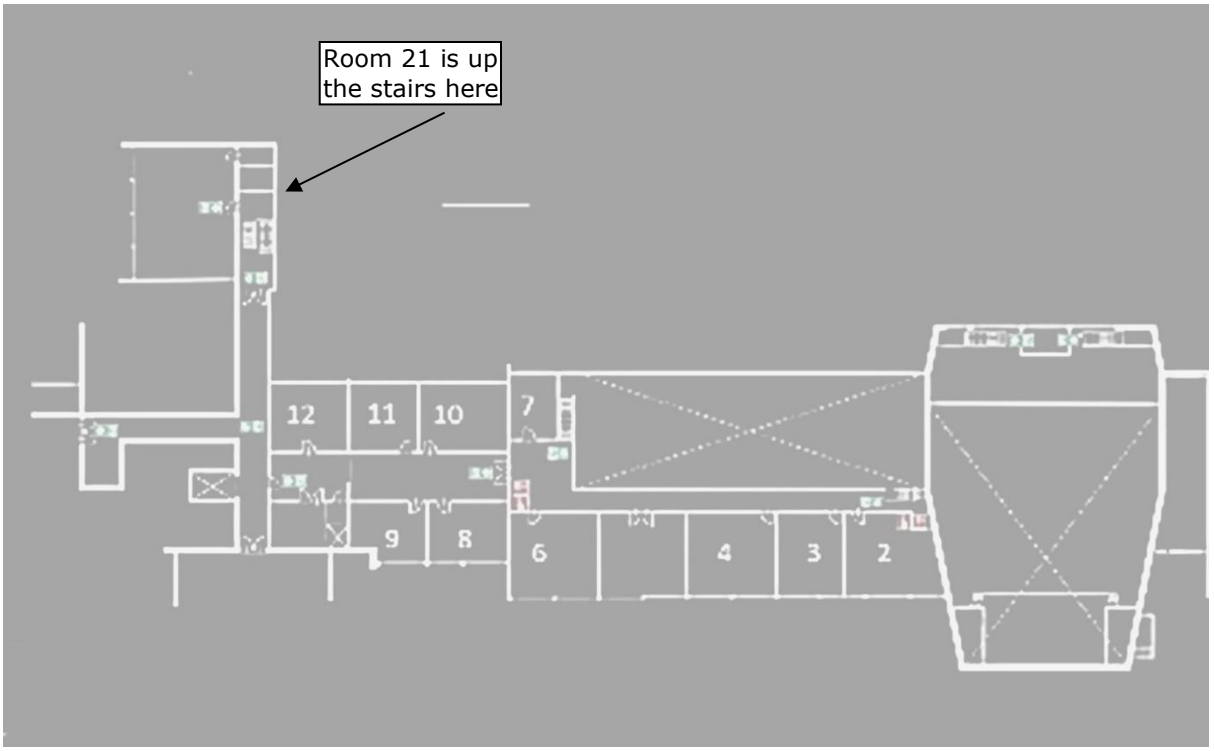
	Name	Institute / University	E-mail address
264	Marcel Visser	Netherlands Institute of Ecology	m.visser@nioo.knaw.nl
265	Fleur Visser	University of Amsterdam	fvisser@kelpmarineresearch.com
266	Ingrid Visseren-Hamakers	Radboud University Nijmegen	ingrid.visseren@ru.nl
267	George van Voorn	Wageningen University & Research	george.vanvoorn@wur.nl
268	Lisenka de Vries	Netherlands Institute of Ecology	l.devries@nioo.knaw.nl
269	Renske Vroom	Radboud University Nijmegen	renske.vroom@ru.nl
270	Dedmer van de Waal	Netherlands Institute of Ecology	d.vandewaal@nioo.knaw.nl
271	Shengnan Wang	Utrecht University	s.wang4@uu.nl
272	Bingxin Wang	Wageningen University & Research	bingxin.wang@wur.nl
273	Maryann Watson	University of Groningen	m.s.watson@rug.nl
274	Ellen Weerman	HAS University of Applied Sciences/ NIOO-KNAW	e.weerman@has.nl
275	Elke Wenting	Wageningen University & Research	elke.wenting@wur.nl
276	Sofie te Wierik	University of Amsterdam	s.a.tewierik@uva.nl
277	Sara Wijburg	Utrecht University	sara.wijburg@rivm.nl
278	Sterre Witte	Royal Netherlands Institute for Sea Research	sterre.witte@nioz.nl
279	Iris de Wolf	University of Amsterdam	irisdewolf49@gmail.com
280	Marcel Wortel	Sovon Vogelonderzoek Nederland	marcel.wortel@sovon.nl
281	Jasper Wubs	Netherlands Institute of Ecology	j.wubs@nioo.knaw.nl
282	Hao Yu	Wageningen University & Research	hao1.yu@wur.nl
283	Isabelle van der Zanden	Netherlands Institute of Ecology	i.vanderzanden@nioo.knaw.nl
284	Shudong Zhang	Vrije Universiteit Amsterdam	sd.zhang@vu.nl
285	Nan Zhang	University of Amsterdam	nanzhang1078@gmail.com
286	Liting Zheng	Utrecht University	l.zheng1@uu.nl
287	Mark Zwart	Netherlands Institute of Ecology	m.zwart@nioo.knaw.nl
288	Joeri Zwerts	Utrecht University	j.a.zwerts@uu.nl

Practical information

Ground floor



1st floor



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