NAEM 2024

Netherlands Annual Ecology Meeting

13 & 14 February 2024

Congrescentrum De Werelt, Lunteren

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X (@NERN_network): #NAEM2024

Programme

Tuesday 13 February

08:30	**Main Entrance**
	Registration
	Air / Fire
	Setting up posters / Coffee and tea
10:15	**Word of Welcome (Earth)**
	Plenary 1: "Applied perspectives" The magnitude and rate of biodiversity loss is alarming, especially considering its contribution to people. Our distinguished speakers will delve into the mechanisms that underlie shifts in biodiversity and unveil their practical relevance in solving real-world challenges. Visionaries behind the 'Center for Biodiversity Dynamics in a Changing World' and the 'Wageningen Biodiversity Initiative,' our speakers will share their invaluable insights gained from these transformative initiatives and shed light on the practical applications of these approaches within the realms of food systems, landscapes, and societies.
10:30	**Deep-time, large-scale perspectives on biodiversity dynamics - implications for biosphere stewardship** (**Jens Christian Svenning**, Aarhus University, Denmark)
11.15	**Cocreating Nature-Positive Futures: a personal reflection on pathways to catalyse change** (**Liesje Mommer**, Wageningen University)
12:00	**Lunch (Restaurant)**

	Earth	Water	Room 21	Rooms 2 & 3	Rooms 10 & 11
13:30	**Parallel 1a: Attacked from all sides: multiple stressor research across ecosystems and scales**	**Parallel 1b: Impact of biodiversity on disease dynamics in natural and managed systems**	**Parallel 1c: Environmental impacts on animal movement**	**Parallel 1d: Restoring biodiversity and functioning of freshwater ecosystems**	**Workshop 1: Your data FAIR and at work, preparing and storing ecological data for re-use**
	Conveners: 1. Judith Epping, Wageningen University and Research 2. Annemieke Drost, Netherlands Institute of Ecology 3. Elke Wenting, Wageningen University and Research/ Radboud University 4. Annalieke Bakker, Wageningen University and Research/ University of Amsterdam	*Conveners*: 1. Bob Douma, Wageningen University and Research 2. Clara Kohler, National Institute for Public Health and the Environment / Wageningen University and Research	*Conveners*: 1. Rosemarie Kentie, Royal Netherlands Institute for Sea Research 2. Hans Linssen, University of Amsterdam 3. Jenna Edwards, Royal Netherlands Institute for Sea Research	*Conveners*: 1. Mandy Velthuis, Radboud University 2. Renske Vroom, Radboud University 3. Suzanne McGowan, Netherlands Institute of Ecology 4. Gea van der Lee, Wageningen University and Research 5. Jip de Vries, Wageningen University and Research 6. Tom van der Meer, Wageningen University and Research	*Conveners*: 1. Kim Ferguson, Data Archiving and Networked Services 2. Cees Hof, Data Archiving and Networked Services 3. Stefan Vriend, Netherlands Institute of Ecology
	Ecosystems worldwide are attacked by an unending list of stressors. From pollution to physical stressors like noise and light, to climate change stressors like droughts and floods. We are only beginning to understand how the combinations of these stressors affect ecosystems and their biodiversity. The urgency is clear, but research is bound by practical constraints. In this session we invite researchers from all ecosystems to present their approaches & findings for tackling this complex field.	Biodiversity is declining at unprecedented rates potentially amplifying hazards of human, animal and plant diseases. Disease occurrence may be amplified because the loss of biodiversity can lead to a concentration of hosts. Evidence from diversified cropping systems demonstrates, however, that the converse can occur as well. In this session, we will explore the intricate relationship between biodiversity and diseases and pests, spanning studies from animals to plants and from natural systems to managed systems.	How do the movements of animals interact with their changing environments? Animal movement plays a crucial role in a wide range of ecological and evolutionary processes which shape biodiversity patterns across space and time. This session will focus on animal movement ecology across scales from the individual to the ecosystem level, and its potential implications for biodiversity. We welcome submissions ranging from foraging behaviour to long-distance population migration and everything in between.	A large abundance of species live or breed in freshwater ecosystems. However, human impacts have led to staggering loss and degradation of these ecosystems globally. In this session we invite contributions discussing practical approaches to revive the recovery of freshwater biodiversity and functioning. These include, for example, improvements on wastewater treatment plants and buffer zones, hydro-morphological restoration, alterations in the soil biogeochemistry and catchment-scale changes in land management. We warmly welcome contributions on all freshwater types, including (but not limited to) lakes, ditches, streams, peatlands, mangroves, and floodplains.	As a researcher, you create data for your own specific purpose. However, with not too much effort you can increase the FAIRness (Findability, Accessibility, Interoperability, and Reusability) of your data significantly. In this interactive workshop we will show and demonstrate how to choose a proper platform for data publishing, which metadata standards to use, what the preferred formats are for your primary research data, and which services you can use to create the ultimate FAIR datasets.

	Earth	Water	Room 21	Rooms 2 & 3	Rooms 10 & 11
13:30	The mammalian ionome as indicator of pollution and deficiencies? Implications for biomonitoring (Elke Wenting, Wageningen University and Research)	Diversity and disease: principles across multiple scales and systems, unresolved questions, and perspectives (Clara Kohler, National Institute for Public Health and the Environment and Bob Douma, Wageningen University and Research)	Multi-species movement ecology in the Wadden Sea (Allert Bijleveld, Royal Netherlands Institute for Sea Research)	Resurrecting habitat coupling in a human-modified lake by creating new islands (C.H.A. van Leeuwen, Wageningen University and Research/ Netherlands Institute of Ecology)	Workshop
13:50	The interactive effect of oxygen and temperature on mortality in riverine amphipods across temporal scales (Wilco Verberk, Radboud University)	Surrounding plant community diversity affects plant-soil feedbacks of single plants (Rutger Wilschut, Wageningen University and Research)	Dunlin diets, space-use, and Individual differences: insights from the Dutch Wadden Sea (Evy Gobbens, Netherlands Institute for Sea Research)	Restoring biodiversity in agricultural landscapes in The Netherlands: the importance of insect emergence from ditches (Hugo Langezaal, Netherlands Institute of Ecology)	
14:10	Foraging behaviour regulates differential patterns of stressor exposure in honeybees (Sydney Wizenberg, York University)	Unravelling disease suppressive mechanisms in intercropping, with a focus on potato late blight (Zohralyn Homulle, Wageningen University and Research)	Ontogeny of migration in a gregarious songbird (Morrison Pot, Netherlands Institute of Ecology)	Flood pulses and fish species coexistence in tropical rivers (Peter van der Sleen, Wageningen University and Research)	
14:30	Short Break (Air / Fire)				
14:40	More than 17,000 tree species are at risk from rapid global change (Coline Boonman, Aarhus University)	Impact of urbanisation on emerging arboviruses in wild bird populations (Tjomme van Mastrigt, Netherlands Institute of Ecology/ Vogeltrekstation)	How do fuelling rates and personality traits influence the timing of spring departure in Red Knots? (Thomas Lameris, Netherlands Institute for Sea Research)	Effects of different irrigation techniques on Sphagnum growth and nutrient dynamics in Sphagnum paludiculture (Sannimari Käärmelahti, Radboud University)	Workhop continues
15:00	Agricultural intensity interacts with landscape arrangement in driving ecosystem services (Swantje Gebhardt, Utrecht University)	Large herbivores feed leaf pathogens in tropical forests (Nacho Villar, Netherlands Institute of Ecology)	Weather-driven bird migration forecasting in dynamic aeroconservation in NW Europe (Maja Bradarić, University of Amsterdam)	Acidifying surface water facilitates Sphagnum survival for restoration and paludiculture (A.H.W. Koks, B-Ware/Radboud University)	
15:20	Mixtures matter – liaising applied ecology and ecotoxicology for comprehensive diagnosis of and solution for biodiversity impacts (Leo Posthuma, Dutch National Institute for Public Health and the Environment)	Gut microbiome diversity correlates with immune development in nestling House Sparrows (Kristen Rosamond)	Large-scale migration and seasonal coastal residency of European grey mullets (Jena Edwards, Netherlands Institute for Sea Research)	Macroinvertebrates as redistributors of environmental pollution (Tom van der Meer, Wageningen University and Research)	
15:40	**Coffee and tea (Air / Fire)**				

	Earth	Water	Room 21	Rooms 2 & 3	Rooms 10 & 11
16:00	**Parallel 2a: Coastal ecology –Restoration, conservation and management**	**Parallel 2b: Fungal diversity under pressure**	**Parallel 2c: Bending the curve using theoretical ecology**	**Parallel 2d: Global change impacts on ecosystem functioning**	**Workshop 2: Sharing experiences in working with stakeholders on bending the curve**
	Conveners: 1. Katrin Rehlmeyer, University of Groningen 2. Jon Dickson, Royal Netherlands Institute for Sea Research	Conveners: 1. Alena Gsell, Leiden University 2. Emilia Hannula, Leiden University 3. Justin Stewart, Vrije Universiteit Amsterdam	Conveners: 1. Monique de Jager, Utrecht University	Conveners: 1. Justine Lejoly, Netherlands Institute of Ecology 2. Mariana Gliesch Silva, University of Amsterdam 3. Alix Vidal, Wageningen University and Research 4. Dina in 't Zandt, Netherlands Institute of Ecology 5 . Rutger Wilschut, Wageningen University and Research	Conveners: 1. Cassandra van Altena, Netherlands Institute of Ecology 2. Sven Teurlincx, Netherlands Institute of Ecology 3. Wolf Mooij, Netherlands Institute of Ecology
	Almost half of the global population lives or recreates in coastal zones; these areas provide a multitude of ecosystem services such as coastal protection, carbon sequestration, food and more. The diverse coastal zones of the world support high biodiversity. Despite their productivity, coastal ecosystems face rapid degradation due to anthropogenic influences and destruction of coastal resources continues. This session focuses on understanding ecosystem functioning, coastal restoration, ongoing threats and holistic coastal management techniques.	Fungi play pivotal roles in terrestrial and aquatic processes such as carbon and nutrient cycling. However, we are still just beginning to understand species and functional diversity of fungi, and how global change affects fungal communities and their interactions with other organisms. In this session we seek contributions on fungal diversity across all habitats, fungal diversity under global change, or approaches on restoring fungal diversity in theoretical or practical examples.	There is a need for understanding the patterns and processes of ecosystem recovery; ideally, we can improve the speed, magnitude, and efficiency of ecosystem recovery by means of a general theoretical framework to guide restoration practices. In this session, we highlight theoretical approaches that can help to inhibit biodiversity decline and perhaps even bend the curve.	In a rapidly changing world, biodiversity loss is threatening ecosystem functioning. Global change alters a myriad of above-belowground interactions involving plants, biota and soil biogeochemistry. To predict ecosystem changes and protect ecosystem functioning, it is crucial to understand how global change affects aboveground and belowground interactions. We welcome contributions exploring global change effects on different ecosystem functions above- and belowground. We particularly seek studies linking biodiversity and soil biogeochemistry, and interactions between plants and their associated above- and belowground biota.	One of the most startling aspects of the biodiversity crisis is how much we know and how unable we are to act upon what we know. Collaboration between scientists and stakeholders on social-ecological challenges is thought to lead to actionable knowledge and knowledgeable action. But working with people with diverse expertise and backgrounds is not always easy. In this workshop we want to share experiences on case studies in natural, agricultural and urban areas.

	Earth	Water	Room 21	Rooms 2 & 3	Rooms 10 & 11
16:00	Exploring possibilities for subtidal eelgrass restoration in the Dutch Wadden Sea (Katrin Rehlmeyer, University of Groningen)	Fungal involvement on organic matter deposition on the smallest aggregate fraction (Elly Morriën, University of Amsterdam)	Can estuarine ecosystems adapt to climate change? (Johan van de Koppel, Netherlands Institute for Sea Research)	Soil biodiversity-ecosystem functioning (sBEF) relationships depend on global change drivers (Alejandro Berlinches de Gea, Wageningen University and Research)	Workshop
16:20	Who lives in a pear tree under the sea? (Jon Dickson, University of Groningen)	Climate and landuse jointly shape arbuscular mycorrhizal fungal biodiversity loss in a tropical mountain ecosystem (Justin Stewart, Vrije Universiteit Amsterdam)	A population-dynamical model to optimise agricultural landscape management for natural pest control (Laura Mansier, University of Amsterdam)	What is driving grassland plant-soil feedback under drought? (Eileen Enderle, University of Amsterdam)	
16:40	How SANDsitive are seafloor animals in the Wadden Sea? (Tjitske Kooistra, Delft University of Technology/ Netherlands Institute for Sea Research)	Stronger decrease in ectomycorrhizal vs total fungal biomass with tree harvest intensity (Steven de Goede, Netherlands Institute of Ecology)	Quantifying the relative contribution of selection, dispersal and stochastic processes to local community assembly (Jelyn Gerkema, Utrecht University)	Next-Gen Restoration: Soil biodiversity and evaluating ecosystem recovery in temperate woodlands (Giles Ross, Netherlands Institute of Ecology)	
17:00	Short break (Air / Fire)				
17:10	Hotspots in Peril: Identifying mismatches in Seafloor Conservation Prioritization in shallow coastal seas (Kasper Meijer, University of Groningen)	Impoverishment of plant-fungi co-occurrence networks in mountains through roadside disturbance (Dajana Radujkovic, University of Antwerp)	Speciation in a MacArthur model: a numerical approach (Joshua Dijksman, University of Amsterdam)	Assessing the effect management intensity and increased soil microbial biodiversity on the soil agro-ecological functioning (Rosa Boone, Radboud University)	
17:30	Ridge-runnel patterns as early indicators of tidal ecosystem shifts in estuaries (Gregory Fivash, Royal Netherlands Institute for Sea Research)	The effects of changing temperatures on diatom-chytrid dynamics and carbon fluxes to lake sediments (Lisa Morales, University of Geneva)	A joint model for estimating species distributions and environmental characteristics from point-referenced data (Lisa Tostrams, National Institute for Public Health and the Environment)	Contribution of agricultural fields for conservation of arthropod populations (Iryna Litovska, Wageningen University and Research)	Workshop continues
17:50	Coastal squeeze threatens dune species richness (Eva Lansu, Royal Netherlands Institute for Sea Research)	Transparent soil: promising novel technique to revolutionize the cultivation of AM fungi (Malin Klein, Vrije Universiteit Amsterdam)	Decline of shorebirds: a matrix population model for the semipalmated sandpiper (Lia Hemerik, Wageningen University and Research)	Can earthworms thrive and influence rock weathering in an artificial organo-mineral system? (Tullia Calogiuri, Wageningen University and Research)	

18:10	**Drinks (Air / Fire) and dinner afterwards (Restaurant)**
19:30	**Workshop 3: Infrastructure needs for experimental aquatic ecology (Water)** Suzanne McGowan, Koos Biesmeijer and Tjeerd Bouma What experimental facilities do we need to address the grand challenges for aquatic ecology in the coming decades? Climate change, habitat loss and pollution are contributing to a water quality and biodiversity crisis. As part of the Dutch National Roadmap for large scale infrastructure, we have an opportunity to bid for new national experimental facilities. We invite Netherlands ecologists to come along to this workshop to help develop a consensus on what the discipline needs.
19:30	**Poster session 1: Odd-numbered posters (Air)**
21:00	**Evening Lecture**

Wednesday 14 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: A non-toxic environment to protect biodiversity**	**Parallel 3b: Predator ecology - monitoring, impact & conservation**	**Parallel 3c: Bending the curve: biodiversity friendly solar parks**	**Parallel 3d: DNA barcodes for biodiversity research**	**Workshop 4: Bending the curve of biodiversity decline, for real**
	Conveners: 1. Annemarie van Wezel, University of Amsterdam 2. Paul van den Brink, Wageningen University and Research	*Conveners:* 1. Esther Swankhuisen, University of Groningen 2. Pieter Otte, University of Groningen	*Conveners:* 1. Thijs Fijen, Wageningen University and Research 2. Karen Krijgsveld, Wageningen University and Research	*Conveners:* 1. Kevin Beentjes, Naturalis Biodiversity Center 2. Duong Vu, Westerdijk Fungal Biodiversity Institute 3. Kathryn Stewart, Leiden University	*Conveners:* 1. Rascha Nuijten, Future for Nature Foundation 2. Ignas Heitkönig, Wageningen University and Research
	All those chemicals in our waters and soils, how do they affect biodiversity? And how important is it to stronger connect the research communities on environmental chemistry and toxicology to those on ecology, evolutionary biology and biodiversity? This session will provide some prime examples on modelling, mesocosm and field work that provides a better understanding on the relevance of chemical pressures for bending the curve for biodiversity, and what can be solutions to lower these pressures.	Many changes are occurring amongst predators: some examples are the return of wolves and golden jackals in Europe, the unknown conservation status and decline of mustelids in the Netherlands, and the growing recognition of domestic cats as invasive species worldwide. These changes lead to heated debates in society. In this session, we explore important research questions: How do we effectively monitor predator species? What roles do they play within ecosystems? And, what long-term conservation measures should we take?	In order to produce large amounts of renewable energy many large-scale solar parks are built in agricultural landscapes where the current biodiversity levels are low. If these parks are being managed biodiversity-friendly, they could contribute to halting the biodiversity decline in agricultural landscapes. In this session we will focus on the current below- and above-ground biodiversity values of solar parks, as well as how to improve these in a practical sense.	Stemming biodiversity loss requires knowing what species are present, and where, for effective monitoring and management. DNA tools offer a powerful approach that enabls species identification, from focal species or complex communities via blood, tissue, bulk, or environmental samples (eDNA), applied across myriad biodiversity assessments and conservation practices. This session focuses on transformative molecular methods to fill knowledge gaps in biodiversity research, including the development of tools that support these techniques.	In this workshop we would like to focus on how we can we have a more direct impact on bending the curve of biodiversity decline. Rather than formally presenting papers we would like the participants to communally co-create the added meaning of their research, to provide additional services and to harvest more fulfilment from their science - without losing track of the project goals and timelines. Tools, tips and support from peers contribute to a larger impact.
08:30	Effects of global change on the emission, fate, effects and risks of chemicals in aquatic ecosystems (Paul Van den Brink, Wageningen University and Research)	Prey tracking and predator avoidance in tropical forest mammals: a camera-trapping approach (Patrick Jansen, Wageningen University and Research)	EcoCertified Solar Parks: guidelines and a label for biodiversity-friendly solar parks (Karen Krijgsveld, Wageningen University and Research)	Upscaling biodiversity initiatives across the Netherlands: ARISE and e3DNA (Kevin Beentjes, Naturalis and Kathryn Stewart, Leiden University)	Workshop

	Earth	Water	Room 21	Rooms 2 & 3	Rooms 10 & 11
08:50	Assessing the Behavioural Sensitivity of Gammaridae to Pesticides and Pharmaceuticals (Elien Versteegen, Wageningen University and Research)	Habitat selection of a threatened felid in a human-dominated landscape: an imperative study on cheetah in southern Africa (Nynke Wemer, University of Groningen)	The impact of solar parks on plant biomass and earthworm and nematode communities (Luuk Scholten, Wageningen University and Research)	Insulation QuickScan: Cavity wall airborne E-DNA sampling to detect Bats n (Willem van Stein, SGS Global Biosciences Center)	
09:10	Physiological and behavioral responses of blue mussels to chemicals leaching from offshore wind turbine coatings (Katharina Alter, Netherlands Institute for Sea Research)	Wild cat in the Netherlands (Bram Houben, ARK Rewilding Nederland)	Ecosystem impacts of solar farms in temperate agricultural systems (Fabio Carvalho, Lancaster University)	Extracting quantitative information from eDNA metabarcoding (Elsa Gerard, Naturalis Biodiversity Center/University of Amsterdam)	
09:30	Short Break (Air / Fire)				
09:40	Can strip cropping enhance pest management and biodiversity? (Luuk Croijmans, Wageningen University and Research)	Mustelid Mugshots: Monitoring the smallest carnivores with camera traps (Tim Hofmeester, Swedish University of Agricultural Sciences)	Solar parks – the next best thing in insect conservation? (Timea Kocsis, Wageningen University and Research)	ARISE project and the importance of DNA barcode databases for soil fungal diversity research (Hazal Kandemir, Westerdijk Fungal Biodiversity Institute)	Workshop continues
10:00	The long-term ecological effects of single antibiotics and their mixtures on freshwater ecosystems (Dailing Wu, Wageningen University and Research)	Feral cat farewells: the effectiveness of removing feral cats from the island of Schiermonnikoog using TNRC (Esther Swankhuisen, University of Groningen)	Solar energy on former farmland: co-existing with farmland birds (Sylvia de Vries, University of Groningen)	Modelling ecological barriers to invertebrates in the urban environment with DNA and remote sensing techniques (Joeri Morpurgo, Leiden University)	
10:20	Fate and ecotoxicological impact of contaminants of emerging concern in the Dutch Wadden Sea Area (Olga Bernadet, Netherlands Institute for Sea Research)	Mapping the mammalian predator community and their effect on meadow bird breeding success in an agricultural landscape (Rienk Fokkema, University of Groningen)	Mammal populations in solar parks, a new land-use type in the agricultural landscape (Chloé Tavernier, Wageningen University and Research)	The impact of flow-induced fragmentation and homogenization on detectable eDNA quantities (Jelle Dercksen, Delft University of Technology/ Leiden University)	
10:40	**Coffee and tea (Air / Fire)**				
11:00	**Workshop 5: Biodiversity in the political arena: scientists to the rescue (Water)** Inez Flameling, University College Roosevelt Biodiversity and related topics are prominently on the political agenda nowadays. This is good news, but at the same time politicians have a hard time navigating the complex scientific fields and are often bombarded with colored or downright false information from industries and interest groups. Ecologists can help! In this workshop we will discuss the role of science in politics and try out some tools that can help scientists get the message across in political settings.				
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: Unlocking the potential of peatlands: trajectories towards reduced GHG emission and biodiversity restoration**	**Parallel 4b: Countering the Extinction Vortex: Genomic population assessments for Species Conservation**	**Parallel 4c: Shedding light on artificial light at night**	**Parallel 4d: Advancing Biodiversity Monitoring with Satellite and Ground-based Digital Sensor**	**Workshop 6: Writing an ecological journal article: a step-by-step approach**
	Conveners: 1. Matty Berg, Vrije Universiteit Amsterdam Gijs van Dijk, Bware Bjorn Robroek, Radboud University Mariet Hefting, Vrije Universiteit Amsterdam	*Conveners:* 1. Niek Barmentlo, Vrije Universiteit Amsterdam Julia Beets, Vrije Universiteit Amsterdam Manon de Visser, Leiden University	*Conveners:* 1. Kamiel Spoelstra, Netherlands Institute of Ecology Emily Burdfield-Steel, University of Amsterdam	*Conveners:* 1. Thomas Groen, University of Twente Joris Timmermans, TU Delft Geerten Hengeveld, Netherlands Institute of Ecology Daniel Kissling, University of Amsterdam Chantal Huijbers, Naturalis	*Conveners:* 1. Rosanna van Hespen, 10000words.nl
	After centuries of peatland degradation, peatlands now play an important role climate change mitigation strategies, water retention and biodiversity preservation. In this session we will discuss the impacts of the emission reduction strategies, peatland restoration and conservation efforts on peatland functioning, biogeochemistry and biodiversity. We welcome abstracts on both natural and agricultural used peatland to explore how land management and the restoration of natural processes can help to increase soil carbon storage and peatland biodiversity.	To preserve fragile species, ecologists are tasked with solving how to effectively assess populations in need of active management. Genomic tools empower researchers to evaluate population dynamics and viability by measuring migratory genetic introgression and assessing (meta-)population genetic health. This session discusses projects linking population genetic structure to species protection. We welcome abstracts discussing local adaptation and genetic health of populations, as well as more applied genetic monitoring projects.	Artificial light at night (ALAN) has increased significantly over the last few decades and has the potential to disturb a multitude of processes from the cellular up to the ecosystem level. In order to tackle the problems cause by light pollution we need both to understand its effects on different trophic levels and ecosystems as a whole. We also need to test potential mitigation strategies – such as different intensities and spectra of artificial lighting.	There is a growing interest to develop digital twins of the Earth's ecosystems to enhance our understanding and to contribute to preservation efforts. For the development of such ecosystem digital twins, data from satellite and ground-based digital sensors is critical to constrain the simulations and make high- level fidelity forecasts. Within this session, we explore advances in data-fusion of satellite/ground-based digital sensors with AI for high-resolution biodiversity monitoring. Specifically, we explore 1) the advances to create new ecological satellite products that link remote sensing to biodiversity, 2) the design of automated systems for biodiversity monitoring and the analysis of data with machine learning tools, and 3) the adaptability of underlying algorithms across ecosystems within digital twins. With these insights, we hope to encourage the creation of digital twins for biodiversity and ecosystems and to contribute to solving biodiversity issues.	A short course on writing an ecological journal article for MSc and PhD students. Touching on all aspects of the writing process: getting started with an outline, tricks to speed up the writing, developing an interesting narrative, how to write clear and concise texts, and more. After finishing the session you will feel more confident about publishing your ecological research.

	Earth	Water	Room 21	Rooms 2 & 3	Rooms 10 & 11
13:30	Rewetting without land-use change: Eat your peat and have it too (Tom Heuts, Radboud University)	Genomic footprints of urban life in túngara frogs (Peter Moran, Vrije Universiteit Amsterdam)	The attraction of insects to light at night varies with taxon, light colour and time at night (Gabriel Charvalakis, Netherlands Institute for Ecology)	MAMBO at Naturalis: Delving into performances of Machine Learning models for species identification in Computer Vision (Rita Pucci, Naturalis Biodiversity Center)	Workshop
13:50	Impact of dry conditions on Sphagnum establishment in bog restoration and paludiculture (Gabrielle Quadra, Radboud University)	Validating the current Asian elephant subspecies status with whole genome sequences (Jeroen Kappelhof, Wageningen University and Research)	Understanding the effects of landscape elements on flying insect biomass in agricultural landscapes using Bayesian modelling (Robin Lexmond, Radboud University)	AI assisted analysis of sticky-traps as monitoring tool for localized insect biodiversity and biomass (Ate Boerema, Van Hall Larenstein University of Applied Sciences/University of Groningen)	
14:10	Substrate legacy in peatland restoration (Duygu Tolunay, Utrecht University)	Plant metagenomics provide evidence of novel honey bee foraging interactions (Sydney Wizenberg, York University)	How does light pollution affect predator-prey interactions? (Hannah Broeckx, University of Amsterdam)	Advancing terrestrial biodiversity monitoring with satellite remote sensing (Joris Timmermans, Delft University of Technology)	
14:30	Short Break (Air / Fire)				
14:40	Microbiome legacy influences the global warming potential of peatland soil (Marco Cosme, University of Antwerp)	Genetic Diversity and Mitogenome Structure of the Dalmatian pelican (Stijn Kouwenberg, Wageningen University and Research)	Colourful Feeding: Altered Bat Feeding Patterns Under Different Light Spectra (Sander Buddendorf, Netherlands Institute of Ecology)	Investigating the Interplay between Bark Beetle Infestation and Land Surface Temperature as Drivers of Change in Forest Net Primary Productivity (Haidi Abdullah, University of Twente)	Workshop continues
15:00	Response of soil biota to water level management and nutrient input in fen peat (Annick van der Laan, Utrecht University)	Characterisation of deleterious genetic variants in non-model organisms: from present to extinct species (Julia Höglund, Stockholm University/Wageningen University and Research)	Urban Digital Twins for Lighting Intervention Planning: The NorDark-DT Case (Ricardo de Silva Torres, Wageningen University and Research)	Spatio-temporal species distribution modeling to assess biodiversity change (Babak Naimi, Utrecht University)	
15:20	From peatlands to seashores: the importance of holistic Wetscapes (Ralph Temmink, Utrecht University)	Nanopore sequencing in molecular ecological monitoring - with a focus on soil nematodes (Robbert van Himbeeck, Wageningen University and Research)	Development of a Biodiversity Planner (Ton de Nijs, National Institute for Public Health and the Environment)	Building Digital twins: from data pipeline to ecosystem insights (Geerten Hengeveld, Netherlands Institute of Ecology)	
15:40	**Coffee and tea (Air / Fire)**				

16:00	**Earth**
	Plenary 2: "Socio-economic, political, and governance perspectives" Our distinguished speakers will take us on a journey through the critical work of IPBES and UN Sustainable Development Goals and their personal contributions to this pressing global challenge. They will dissect the underlying causes of biodiversity loss and the key leverage points for igniting transformative change, offering a blueprint for practical action. They will emphasize the indispensable roles of policy and governance in effecting meaningful biodiversity and sustainability transformations in the mission to bend the curve of biodiversity loss.
16:00	**Navigating the maze in science and practice: my struggles to unravel and link the causes and consequences of biodiversity** (**Akira Mori,** University of Tokyo, Japan)
16:45	**Nature Beyond Conservation** (**Esther Turnhout**, University of Twente)
17:40	**Awards and Closing Ceremony (Earth)**
18:00	**Farewell drinks (Air / Fire)**
18:30	**Dinner (Restaurant)**
19:30	**End / Travel Home**

NAEM 2024

Presentation Abstracts

Plenary Session 1

Applied perspectives

The magnitude and rate of biodiversity loss is alarming, especially considering its contribution to people. Our distinguished speakers will delve into the mechanisms that underlie shifts in biodiversity and unveil their practical relevance in solving real-world challenges. Visionaries behind the 'Center for Ecological Dynamics in a Novel Biosphere (ECONOVO)' and the 'Wageningen Biodiversity Initiative,' our speakers will share their invaluable insights gained from these transformative initiatives and shed light on the practical applications of these approaches within the realms of food systems, landscapes, and societies.

1. Deep-time, large-scale perspectives on biodiversity dynamics - implications for biosphere stewardship

Jens Christiaan Svenning, Aarhus University, Denmark

We are facing climate conditions unseen in the history of civilization. They pose strong risks for society and biodiversity, but risks that are also difficult to forecast. Here, an integrated large-scale, long-term perspective offers important insights. The last few million years have experienced severe instability in climate and the rise of humans as a global ecological force. These climate variations drove strong ecosystem reorganization, with strong shifts to novel climates causing massive biodiversity losses. Further, there is a consistent pattern of strong ecological changes in the wake of the global spread of Homo sapiens. Extirpation of large vertebrates were, and are, typical, and the associated trophic downgrading had profound ecological effects. Looking ahead, we can forecast intensifying impacts from human activities and human-driven climate change, with potential to cause ecosystem breakdowns and massive biodiversity losses. Achieving a more positive future requires intensified, integrative efforts to solve the climate and biodiversity crises alongside sustainable, democratic development.

2. Cocreating Nature-Positive Futures: a personal reflection on pathways to catalyse change

Liesje Mommer, Wageningen University, The Netherlands

The socio-ecological crises that humanity is facing nowadays are unprecedented – climate change, biodiversity loss to name a few. Tipping points of ecosystems seem close and cascading effects leading to societal imbalance have become imaginable, because of their global and multi-faceted effects. The root causes of these socio-ecological crises are related to human activities: we have already crossed six out of the nine planetary boundaries.

As a mother of two teenagers, I can feel paralysed when considering the negative impacts this will have on system Earth, the uncertainty for the future of our children, and theirs… and geo-political power dynamics that do not seem to care as much as is needed….
As an ecologist, I find it frustrating – haven't we delivered sufficient evidence for the need to stay within planetary boundaries? For the balancing power of nature? If the concerns and the scientific evidence of ecologists alone could have saved the world, we would have made it already a long time ago. So, in 2019 I decided to stop 'doing what I always did, because then we get what we always got' (Einstein).

In this interactive lecture I will provide a personal perspective on my decision to take a different path, and how I navigate the landscape of these uncertain times. What are the lessons that I have learned in the journey of leading the Wageningen Biodiversity Initiative? What is needed to explore 'the wild places' in the system? And in ourselves? How can we catalyse change from the scientific community?

Plenary Session 2

Socio-economic, political, and governance perspectives

Our distinguished speakers will take us on a journey through the critical work of IPBES and UN Sustainable Development Goals and their personal contributions to this pressing global challenge. They will dissect the underlying causes of biodiversity loss and the key leverage points for igniting transformative change, offering a blueprint for practical action. They will emphasize the indispensable roles of policy and governance in effecting meaningful biodiversity and sustainability transformations in the mission to bend the curve of biodiversity loss.

1. Navigating the maze in science and practice: my struggles to unravel and link the causes and consequences of biodiversity

Akira Mori, University of Tokyo, Japan

Advancements in understanding functional consequences of biodiversity changes are emerging from studies in both experimental and natural systems, complemented by insights from community assembly theory. Despite these developments, a comprehensive integration of causes and effects of biodiversity remains elusive. This talk aims to bridge this gap by delving into the interplay between diversity and functional attributes such as primary productivity and organic matter decomposition, highlighting their significance in both theoretical and practical contexts. Then, I will expand the discussion to include a blend of objective evidence and subjective insights, proposing ways in which lessons from biodiversity can address global societal challenges.

2. Nature beyond conservation

Esther Turnhout, University of Twente, The Netherlands

Conservation is not saving nature. This is not because we do not have enough of it, or because conservation suffers from a lack of funding or from problems of implementation. The very concept of conservation is a problem since conservation and exploitation are cut from the same wood. In this talk, I will develop this argument zooming in on the role of science in the parallel constitution of nature, its exploitation, and its conservation. It is for this reason that conservation has been powerless to catalyze transformative change, go beyond reproducing the status quo, and move away from offering false stop-gap solutions that do not address the root causes of nature's ongoing destruction. Although this lack of effectiveness may seem paradoxical because of conservation's self-identification as a 'crisis discipline', the discourse of crisis in fact further facilitates conservation's failure to safeguard human-ecological well-being because it consolidates what has been termed the post-political condition. For conservation, this post-political condition manifests among others in the continued reproduction of a problematic singular concept of nature and an equally problematic singular concept of scientific truth. I suggest that the politicization and pluralization of nature and of knowledge about nature are necessary antidotes to this situation; to open up and disrupt the post-political deadlock that conservation science and practice are currently trapped in. I will conclude my talk by discussing what this means for conservation and biodiversity science, and why these suggestions will face resistance.

Parallel Session 1

1a: Attacked from all sides: multiple stressor research across ecosystems and scales

Conveners: Judith Epping (Wageningen University and Research)
Annemieke Drost (Netherlands Institute of Ecology)
Elke Wenting (Wageningen University and Research/ Radboud University)
Annalieke Bakker (Wageningen University and Research)

Ecosystems worldwide are attacked by an unending list of stressors. From pollution to physical stressors like noise and light, to climate change stressors like droughts and floods. We are only beginning to understand how the combinations of these stressors affect ecosystems and their biodiversity. The urgency is clear, but research is bound by practical constraints. In this session we invite researchers from all ecosystems to present their approaches & findings for tackling this complex field.

1. **The mammalian ionome as indicator of pollution and deficiencies? Implications for biomonitoring**
   Elke Wenting, Henk Siepel, Patrick Jansen
   Wageningen University and Research / Radboud Institute

The ionome - i.e. the elemental composition of organisms - is used in biomonitoring of environmental pollution and potential deficiencies. Biomonitoring uses (larger-sized) animals to assess the (eco)toxic burden or potential deficiencies in areas. Traditionally, the focus is on specific tissues, e.g. liver, kidney, and bones, based on the widely-held assumption that these are the target tissues for (eco)toxic and scarce elements. We evaluated this assumption by examining the full ionome of Wild boar (Sus scrofa) and Red deer (Cervus elaphus), two commonly used mammals for biomonitoring, in a Dutch protected nature reserve (National Park Veluwezoom). We used four individuals per species, and dissected 13 tissues and organs that we measured for 22 elemental concentrations. These included toxic elements (e.g. As, Cd, Pb) and essential scarce elements (e.g. Co, Se, Zn). We found that the ionome was highly variable for both species. No single tissue accurately represented the accumulation of toxic elements or potential deficiencies in the bodies. We noticed a serious lack of reference values, that hampered our attempt to judge about any toxicities or deficiencies. Our findings implied that analyzing commonly used tissues does not necessarily capture bioaccumulation of toxins or potential deficiencies. Our results provide new insights into the mammalian ionome, that are important to put the results biomonitoring studies into perspective.

2. **The interactive effect of oxygen and temperature on mortality in riverine amphipods across temporal scales**
   Wilco Verberk, Natan Hoefnagel, Ignacio Peralta-Maraver, Mathieu Floury, Enrico Rezende
   Radboud University

Here we describe a flexible analytical framework to forecast mortality risks by combining laboratory measurements on tolerance and field temperature records. Our framework incorporates differences in temporal scale and the ecological reality of fluctuations in temperature, and other factors such as oxygen. We investigated the heat tolerance of riverine amphipods acclimated to different temperatures and oxygen levels. By integrating experimental data with high-resolution field data, we derived the daily heat mortality probabilities for different time scales and different climate warming scenarios. By expressing heat stress as a mortality probability rather than an upper critical temperature, these can be used to calculate cumulative annual mortality, allowing the scaling up from individuals to populations. Our findings indicate a substantial increase in annual mortality over the coming decades, driven by projected increases in summer temperatures. Thermal acclimation and adequate oxygenation improved heat tolerance and, importantly, their beneficial effects were magnified on longer timescales. Consequently, acclimation effects appear to be more effective than previously recognized and crucial for persistence under current temperatures. Overall, this framework generates high-resolution forecasts on how rising temperatures, in combination with other environmental stressors such as hypoxia, impact ecological communities.

3. **Foraging behaviour regulates differential patterns of stressor exposure in honeybees**
   Sydney Wizenberg, Amro Zayed, BeeCSI Consortium
   York University

Recent declines in the health of honeybee colonies used for crop pollination pose a considerable threat to global food security. Foraging by honeybee workers likely represents the primary route of exposure to a plethora of toxins and pathogens known to affect bee health, but it remains unclear how foraging

preferences impact colony-level stressor exposure. Resolving this knowledge gap is crucial for enhancing the health of honeybees and the agricultural systems that rely on them for pollination. To address this, we carried out a continental-scale experiment encompassing 456 Canadian honeybee colonies to first characterize pollen foraging preferences in relation to major crops, then explore how foraging behaviour influences patterns of stressor exposure. We used a metagenomic approach to quantify honeybee dietary breadth and found that bees display distinct foraging preferences that vary substantially relative to crop type and proximity, and the breadth of foraging interactions can be used to predict the abundance and diversity of stressors a colony is exposed to. High dietary diversity was associated with increased exposure to pathogens, while low dietary diversity was associated with increased exposure to agro-chemicals. Landscape-level effects bolstered these relationships but were not solely responsible for the strong association. Our work provides the first large-scale empirical evidence that pollen foraging behaviour plays an influential role in determining honeybee stressor exposure.

4. More than 17,000 tree species are at risk from rapid global change

Coline Boonman, Josep Serra-Diaz, Selwyn Hoeks, Wen-Yong Guo, Brian Enquist, Brian Maitner, Yadvinder Malhi, Cory Merow, Robert Buitenwerf, Jens-Christian Svenning
Aarhus University

Agricultural intensification through high use of artificial fertilizer and pest control chemicals, irrigation, mechanization and simplification of crop rotations has enhanced productivity globally. In the Netherlands, these practices combined with the removal of semi-natural landscape elements and landscape homogenization have led to various environmental problems, including eutrophication, desiccation, acidification, and biodiversity loss. Further, ecosystems are not only under stress from food production goals, but also from multiple other demands for the limited space, like recreation, or housing. Strategic spatial landscape design could counteract this trend, but, the scientific understanding of how ecosystem services respond to interactions of agricultural practices and land use composition and configuration is not complete. This study used spatial regression models to explore how agricultural management intensity affects the relationship between spatial composition and configuration metrics and ecosystem service indicators in the Netherlands. We found that the effect of large shares of agricultural land use on species richness, pollination and landscape appreciation was increasingly negative when combined with the burden of highly intensive agricultural practices. With higher agricultural intensity in the surroundings, the positive effects of well-connected natural vegetation on species richness were impaired. In contrast, the negative effects of high-intensity agriculture on pollination service were be buffered well through high shares of natural grassland vegetation. Water-quality related indicators were less affected by variation in spatial metrics and agricultural intensity. The main interactions between intensity and the spatial metrics were robust at varying scales. Our analysis suggests that both low- and high-intensity agriculture can have a place in future sustainable agricultural systems, provided they are integrated in the appropriate spatial layout. Explicitly addressing farming practices in connection to local spatial settings can improve both landscape planning and ecosystem service modelling.

5. Agricultural intensity interacts with landscape arrangement in driving ecosystem services

Swantje Gebhardt, Jerry van Dijk, Martin Wassen, Martha Bakker
Utrecht University

Agricultural intensification through high use of artificial fertilizer and pest control chemicals, irrigation, mechanization and simplification of crop rotations has enhanced productivity globally. In the Netherlands, these practices combined with the removal of semi-natural landscape elements and landscape homogenization have led to various environmental problems, including eutrophication, desiccation, acidification, and biodiversity loss. Further, ecosystems are not only under stress from food production goals, but also from multiple other demands for the limited space, like recreation, or housing. Strategic spatial landscape design could counteract this trend, but, the scientific understanding of how ecosystem services respond to interactions of agricultural practices and land use composition and configuration is not complete. This study used spatial regression models to explore how agricultural management intensity affects the relationship between spatial composition and configuration metrics and ecosystem service indicators in the Netherlands. We found that the effect of large shares of agricultural land use on species richness, pollination and landscape appreciation was increasingly negative when combined with the burden of highly intensive agricultural practices. With higher agricultural intensity in the surroundings, the positive effects of well-connected natural vegetation on species richness were impaired. In contrast, the negative effects of high-intensity agriculture on pollination service were be buffered well through high shares of natural grassland vegetation. Water-quality related indicators were less affected by variation in spatial metrics and agricultural intensity. The main interactions between intensity and the spatial metrics were robust at varying scales. Our analysis suggests that both low- and high-intensity agriculture can have a place in future sustainable agricultural systems, provided they are integrated in the appropriate spatial layout. Explicitly addressing farming practices in connection to local spatial settings can improve both landscape planning and ecosystem service modelling.

6. Mixtures matter – liaising applied ecology and ecotoxicology for comprehensive diagnosis of and solution for biodiversity impacts

Leo Posthuma, Jaap Slootweg, Jaap Postma, Rineke Keijzers
National Institute for Public Health and the Environment (RIVM-DMG)

Agricultural intensification through high use of artificial fertilizer and pest control chemicals, irrigation, mechanization and simplification of crop rotations has enhanced productivity globally. In the Netherlands, these practices combined with the removal of semi-natural landscape elements and landscape homogenization have led to various environmental problems, including eutrophication, desiccation, acidification, and biodiversity loss. Further, ecosystems are not only under stress from food production goals, but also from multiple other demands for the limited space, like recreation, or housing. Strategic spatial landscape design could counteract this trend, but, the scientific understanding of how ecosystem services respond to interactions of agricultural practices and land use composition and configuration is not complete. This study used spatial regression models to explore how agricultural management intensity affects the relationship between spatial composition and configuration metrics and ecosystem service indicators in the Netherlands. We found that the effect of large shares of agricultural land use on species richness, pollination and landscape appreciation was increasingly negative when combined with the burden of highly intensive agricultural practices. With higher agricultural intensity in the surroundings, the positive effects of well-connected natural vegetation on species richness were impaired. In contrast, the negative effects of high-intensity agriculture on pollination service were be buffered well through high shares of natural grassland vegetation. Water-quality related indicators were less affected by variation in spatial metrics and agricultural intensity. The main interactions between intensity and the spatial metrics were robust at varying scales. Our analysis suggests that both low- and high-intensity agriculture can have a place in future sustainable agricultural systems, provided they are integrated in the appropriate spatial layout. Explicitly addressing farming practices in connection to local spatial settings can improve both landscape planning and ecosystem service modelling.

1b: Impact of biodiversity on disease dynamics in natural and managed systems

Conveners: Bob Douma (Wageningen University and Research)
Clara Kohler (National Institute for Public Health and the Environment / Wageningen University and Research)

1. Diversity and disease: principles across multiple scales and systems, unresolved questions, and perspectives

Clara Kohler, Bob Douma
National Institute for Public Health and the Environment, Wageningen University and Research

Biodiversity is declining at unprecedented rates potentially amplifying hazards of human, animal and plant diseases. Disease occurrence may be amplified because the loss of biodiversity can lead to a concentration of hosts. Evidence from diversified cropping systems demonstrates, however, that the converse can occur as well. In this session, we will explore the intricate relationship between biodiversity and diseases and pests, spanning studies from animals to plants and from natural systems to managed systems.

2. Surrounding plant community diversity affects plant-soil feedbacks of single plants

Rutger Wilschut
Wageningen University and Research

Feedback interactions between plants and plant-beneficial or -antagonistic soil biota ('plant-soil feedbacks' (PSFs)) are thought to partly underlie plant community dynamics, but most evidence is based on single-plant studies. However, the accumulation of soil biota by single plants may depend on surrounding plant community diversity, but how this affects PSFs remains unexplored. Here, we present results of a two-phase experiment, in which we first grew individuals of focal plants (N = 4 species) in single mesh pots that were placed in mesocosms containing plant communities of different diversities, including or excluding conspecific individuals of the focal species. We subsequently examined focal plant growth in soils from all the different mesh pots, testing the hypotheses that increasing diversity of communities with, but not without, conspecifics weakens subsequent negative PSFs of focal plants on conspecifics, and that increasing community diversity strengthens negative PSF effects on heterospecific plants. Our results show that surrounding community diversity and presence of conspecifics can interactively affect subsequent plant-soil feedback responses of conspecific plants, yet in species-specific ways. These results suggest that impacts of key antagonistic or beneficial host-specialist soil biota on plant performance can drastically weaken when surrounding plant community diversity increases.

3. Unravelling disease suppressive mechanisms in intercropping, with a focus on potato late blight

Zohralyn Homulle, Niels Anten, Tjeerd Jan Stomph, Wopke van der Werf, Jacob Douma
Wageningen University and Research

Crop diversification, through intercropping, is known to suppress diseases, and could thus be a sustainable component of integrated crop protection. Nevertheless, it is not clear how exactly intercropping can reduce diseases. Field experiments were conducted to explore disease suppressive mechanisms, in potato strip-cropped with grass, faba bean, or maize, focussing on potato late blight (*Phytophthora infestans*). Next to disease severity assessments, measurements regarding the disease suppressive mechanisms were taken, such as microclimate within the potato canopy and number of incoming particles. Strip-crop treatments, especially with grass, showed significant reductions in disease severity compared with potato monoculture. The choice of companion crop species can be important to maximise disease suppression; the crop's statue can affect disease suppressive mechanisms, such as modifying the microclimate, creating a barrier or inducing resistance in the neighbouring crop. Investigating the different mechanisms in a late blight model revealed that in the intercrop, changes in microclimate played a key role in disease suppression. This explains why grass as a companion crop had the highest reduction in late blight. Enhancing our understanding of the various mechanisms at play in intercrop systems, could help us to better optimise intercrop designs to reduce potato late blight, and potentially other diseases.

4. Impact of urbanisation on emerging arboviruses in wild bird populations

Tjomme van Mastrigt
Netherlands Institute of Ecology

I am working on an integrated population model to quantify the impact of the 2016-2018 Usutu virus outbreak on blackbird populations in the Netherlands. In this model I make use of diagnostic data from

our live bird surveillance, capture mark-recapture data and count data, as well as land use and other environmental data. Both disease prevalence and demographic parameters in blackbirds vary considerably in both space and time, and these variations may well relate to environmental factors such as the level of urbanization. Interestingly, these days a large proportion of the blackbirds lives in high density (but low diversity) urban populations rather than the original lower density, but more diverse forest communities. In my model I will be exploring whether urbanization may play a role by affecting disease transmission dynamics. So, although the model I could present on is primarily aimed at estimating population-level disease impacts (and therefore not strictly focused on disease-diversity relationships), urbanization/host community characteristics will be incorporated into the model and could be the focus of a talk.

5. **Large herbivores feed leaf pathogens in tropical forests.**
Nacho Villar, Carine Emer, Natália Melo, Valesca Ziparro, Sergio Nazareth, Mauro Galetti
Netherlands Institute of Ecology

In forest ecosystems, natural enemies have an important role in regulating plant recruitment and diversity. Large mammalian herbivores may interfere with plant consumption and leaf damage by important enemy guilds such as invertebrate herbivores and pathogens, triggering indirect trophic cascades. Yet, the impact of local extinctions of large herbivores on plant-enemy interactions is relatively unknown.
We experimentally tested the effects of defaunation of large mammalian herbivores on leaf damage of 3,350 understory plants in 43 open-closed experimental plot pairs in the Atlantic tropical rainforest of Brazil. Plants released from large herbivores had 9% less leaf damage. This difference was due to lower incidence of leaf pathogens (29%), whereas no consistent differences between treatments in insect herbivory were found. Defaunation was associated to dilution effects: large herbivore exclusion increased plant species richness, which in turn led to a decline in pathogen damage.
Our results suggest that large herbivores decrease the dilution potential of plant communities against natural enemies and rather reinforce their top-down impact on vegetation through plant pathogens, demonstrating a previously overlooked indirect cascading effect of large herbivores extinction on forest ecosystems. Large herbivores and plant pathogens might have synergistic effects in regulating the diversity of plant communities in some of the most diverse ecosystems on Earth.

6. **Gut microbiome diversity correlates with immune development in nestling House Sparrows**
Kristen Rosamond, Brian Trevelline, Catherine Andreadis, Gábor Czirják, Jennifer Houtz, Kevin Matson, Natalie Morris, Andrew Moeller, Melissah Rowe
University of Missouri-St. Louis

The biodiversity of microorganisms (i.e., the microbiome) that an organism lives in symbiosis with can broadly impact that individual's biological functioning. For instance, depauperate microbiomes can lead to immunological dysfunction. Specifically, the intestinal microbiome is known to impact immunological development, especially in early life. To study these dynamics, germ-free experimental systems are key, as they allow for controlled comparisons of organisms in both the presence and absence of microbes. We established a germ-free system for wild birds to determine how gut microbes impact host physiology. Having collected eggs from a captive colony of House Sparrows, we raised in sterile microisolators both germ-free nestlings (fed with sterilized food) and conventionalized nestlings (fed with sterilized food plus fecal microbes from adult sparrows). Using plasma from seven-day-old nestlings from both experimental groups and a parent-raised control group, we quantified nine immune indices to evaluate if gut microbiome biodiversity impacts immune function in an altricial bird. Preliminary results indicate that six of these indices were significantly reduced in germ-free nestlings, providing strong evidence that the gut microbiome correlates with avian immune development. Understanding how gut microbes influence wild avian physiology will help clarify how animals' microbiomes, and their associated biodiversity, can influence wildlife health.

1c: Environmental impacts on animal movement

Conveners: Rosemarie Kentie (Royal Netherlands Institute for Sea Research NIOZ)
Hans Linssen (University of Amsterdam)
Jena Edwards (Royal Netherlands Institute for Sea Research NIOZ)

How do the movements of animals interact with their changing environments? Animal movement plays a crucial role in a wide range of ecological and evolutionary processes which shape biodiversity patterns across space and time. This session will focus on animal movement ecology across scales from the individual to the ecosystem level, and its potential implications for biodiversity. We welcome submissions ranging from foraging behaviour to long-distance population migration and everything in between.

1. Multi-species movement ecology in the Wadden Sea

Allert Bijleveld
Royal Netherlands Institute for Sea Research

Movement is an important ecological phenomenon, and the field of movement ecology is rapidly growing due to technological advancements. One of the current frontiers is to study movement of different species in the same environment. Here, I will broadly introduce movement ecology and present how we utilise the Wadden Sea ATLAS tracking system (WATLAS) to study community movement ecology in the Dutch Wadden Sea. In the summer of 2023, we tagged nine species of shorebirds on the island of Griend and tracked them at high spatiotemporal resolution. I will describe space use and site fidelity of these species and discuss the differences between species in the context of niche-use and sensitivity to anticipated habitat loss with sea level rise.

2. Dunlin diets, space-use, and Individual differences: insights from the Dutch Wadden Sea

Evy Gobbens
Royal Netherlands Institute for Sea Research

Understanding the relationship between the diet of an animal and its spatial habitat use is essential to predicting current and future population distributions. Dunlins (*Calidris alpina*) are the most abundant wader species in the Dutch Wadden Sea, yet little is known about their diet and preferred habitat. Dunlins also exhibit one of the largest variations in morphological features such as bill length amongst wader species in the Wadden Sea. We, therefore, studied the diet of dunlins and their space-use of the Wadden Sea and linked individual characteristics, such as bill length, to individual differences in diet, foraging behavior, and space-use. Between August and November 2022, we collected feces of individual dunlins (n=271) and recorded their foraging behaviors (n=166). Foraging behaviors and prey intake success rates were noted for each individual, while DNA metabarcoding has been used on feces samples to identify prey species. recorded foraging behaviors of individual dunlins (n=166) and collected feces of these same individuals and others (n=271). Additionally, we equipped 36 dunlins with lightweight (~1.1 gram) ATLAS tags to identify important foraging areas. These data allow us to connect space-use, diet, and foraging behavior of individual dunlins that, together with their prey species' distributions, can help us identify the dunlin's habitat-associations and most important foraging hotspots in the Dutch Wadden Sea.

3. Ontogeny of migration in a gregarious songbird

Morrison Pot
Netherlands Institute of Ecology

Migration is a spectacular natural phenomenon that includes massive movements and epic performances on a global scale. The observation that juvenile songbirds navigate to population-specific wintering grounds they have never visited before without guidance from experienced conspecifics has inspired generations of scientists. Experimental work suggests that songbirds genetically inherit a migration program to migrate into a population-specific direction at the right time of the year: a 'clock-and-compass' system. Although we have gained extensive knowledge about the cues songbirds can use to navigate, experiments have mainly been performed using individuals expressing migratory behaviour in captivity. To understand how migration is truly performed and how environmental variation encountered during early life may shape future migrations requires experiments with free-flying songbirds. We are filling this knowledge gap by using novel tracking technology to perform orientation experiments with wild songbirds. More specifically, we use a modern approach to a classic displacement experiment to understand how Common Starlings Sturnus vulgaris develop individual migration patterns and show that juveniles do not solely use a clock and compass.

4. How do fuelling rates and personality traits influence the timing of spring departure in Red Knots?

Thomas Lameris, Tohar Tal
Royal Institute for Sea Research

In a warming climate, migratory birds are under pressure to adjust their annual cycles, including timing of migration and breeding. The most effective way to achieve earlier arrival on the breeding area is earlier departure from non-breeding areas, but flexibility in departure timing has been considered rather inflexible. In Red Knots (*Calidris canutus islandica*) we studied whether timing of departure is constrained by time and resources required for spring migration preparation, as well as the role of personality traits in this process. In two consecutive years we took Red Knots into captivity during winter, controlled access to food during spring migration preparation, followed by release into the Wadden Sea to track timing of migration. With longer access to food, birds sped up migration preparation and were heavier and further into summer plumage at release, and these birds also departed earlier from the Wadden Sea. Further variation between individuals was partially explained by personality: especially fast-exploring individuals delayed departure after having less access to food in captivity. These results suggest that speed of migration preparation and departure timing are flexible, with food availability forming a potentially important constraint limiting advancements in migration timing, and perhaps even more so for fast-exploring individuals.

5. Weather-driven bird migration forecasting in dynamic aeroconservation in NW Europe

Maja Bradarić, Bart Hoekstra, Emiel van Loon, Judy Shamoun-Baranes
University of Amsterdam

The timing of nocturnal bird migration is mainly influenced by average seasonal phenology and day-to-day changes in weather conditions. The inconsistent availability of weather conditions suitable for migration leads to a pulsed nature of nocturnal migration, with most migration occurring over just a few nights every year. This is particularly so for NW Europe, where due to the constant passing of air pressure systems and perilous water bodies to cross along the flyways, birds have to carefully time their departure for rare optimal conditions. By extension, if understood well, implementing conservation action such as wind turbine curtailments — temporarily slowing down turbines to prevent collisions — during a few carefully chosen nights within a migration season, can have large conservation benefits with minimal impact on the energy grid. The Netherlands has taken a progressive step towards dynamic aeroconservation with wind turbine curtailments applied predominantly in off- and increasingly in on-shore wind parks during forecasted migration waves. We give a brief overview of the weather conditions that drive mass migration events (and a lack thereof) in NW Europe and show how this knowledge can be used to operationally provide low-altitude migration forecasts for large-scale curtailment. In addition, we present current and future modelling approaches, and address the capabilities of these forecast models and the challenges predicting these extreme events. Finally, we also show some ongoing work mapping mass migration events over the Netherlands for more fine-scale, sub-national forecasts in the future.

6. Large-scale migration and seasonal coastal residency of European grey mullets

Jena Edwards, Anthonie Buijse, Hendrick Winter, Allert Bijleveld
Royal Institute for Sea Research

Found in temperate and subtropical waters worldwide, grey mullets (family Mugilidae) are common across coastal, brackish, and fresh water habitats where they have supported fisheries dating back millennia. Despite their widespread occurrence and commercial importance, almost nothing is known about the movement ecology of grey mullets. In the coastal European waters of the Wadden Sea, a lack of knowledge of the seasonal occurrence, home range size, and migratory behaviours has hindered management efforts in the face of local declines for one species, the thicklip grey mullet (*Chelon labrosus*), spurring the need for additional research. To address this knowledge gap and expand our knowledge of the movements of grey mullets in general, we tagged 129 individuals from three species with acoustic transmitters and data storage tags to monitor their movements both within the Wadden Sea and across their broader migratory ranges. Movement data collected from both telemetry types will be used to determine both the role of the Wadden Sea as a seasonal foraging ground for grey mullets, and to identify important habitats and movement pathways in both coastal and offshore regions. These data will improve fundamental knowledge of mullet life histories and will guide the conservation and management of grey mullets in this important ecosystem.

1d: Restoring biodiversity and functioning of freshwater ecosystems

Conveners: Mandy Velthuis (Radboud University)
Renske Vroom (Radboud University)
Suzanne McGowan (Netherlands Institute of Ecology)
Gea van der Lee (Wageningen University and Research)
Jip de Vries (Wageningen University and Research)
Tom van der Meer (Wageningen University and Research)

A large abundance of species live or breed in freshwater ecosystems. However, human impacts have led to staggering loss and degradation of these ecosystems globally. In this session we invite contributions discussing practical approaches to revive the recovery of freshwater biodiversity and functioning. These include, for example, improvements on wastewater treatment plants and buffer zones, hydro-morphological restoration, alterations in the soil biogeochemistry and catchment-scale changes in land management. We warmly welcome contributions on all freshwater types, including (but not limited to) lakes, ditches, streams, peatlands, mangroves, and floodplains.

1. Resurrecting habitat coupling in a human-modified lake by creating new islands

C. van Leeuwen, J. Vonk, H. van der Geest
Wageningen University and Research/Netherlands Institute of Ecology

Energy flows among terrestrial, pelagic and benthic habitats are essential for the functioning of freshwater ecosystems. This habitat coupling is often impacted by human landscape modifications. A large-scale (70,000ha) human-modified aquatic ecosystem with limited habitat coupling is lake Markermeer in the Netherlands. This homogeneous lake was created by constructing riprap dikes in a former marine estuary. The lake is surrounded by riprap dikes, restricting connections to the surrounding landscape, and its uniform 4m deep turbid water column limits light availability for benthic organisms. To increase the ecological integrity of this degraded Natura-2000 lake, the large-scale habitat restoration project Marker Wadden was initiated: a 1300ha seven-island archipelago intermixed with shallower sheltered waters was newly created. In the new shallow waters light availability increased for benthic organisms and the new gradual land-water transitions were expected to reconnect the aquatic and terrestrial habitats. We hypothesized that this restoration project will increase benthic primary production and flows of terrestrial organic matter into the aquatic ecosystem, and that therefore macroinvertebrates will profit from increased availability of carbon sources. In this talk we present data on primary production, macroinvertebrates and stable isotope analyses outlining how the Marker Wadden restoration project affected habitat coupling in lake Markermeer.

2. Restoring biodiversity in agricultural landscapes in The Netherlands: the importance of insect emergence from ditches

Hugo Langezaal
Netherlands Institute of Ecology

The intensification of agriculture is one of the main drivers of biodiversity loss in rural areas. Our current agricultural systems have a major negative impact on the biodiversity and functioning of freshwater ecosystems. Among the causes are high nutrient fluxes from land to water. Many studies consider the importance of subsidies from land towards water, but subsidies from water towards land are often overlooked, let alone in agricultural systems. Insects metamorphosing from aquatic larvae to winged adult compose a part of the transfer in energy and matter towards land. Currently, many of the remaining insect biomass and species found in agricultural systems is thought to have an aquatic origin. Here we present results on the emergent insect community composition and biomass along a gradient of land use intensity in The Flower Bulb Region in The Netherlands. We aim to find out the magnitude of how aquatic emergent insects subsidize terrestrial systems along a land use intensity gradient and how this is influenced by corresponding water quality parameters such as nutrient concentrations. Results will be used in a food web approach to restore biodiversity in agricultural systems in both terrestrial and aquatic habitats, with special regard to the interconnectedness of both.

3. Flood pulses and fish species coexistence in tropical rivers

Peter van der Sleen, Maartje Rams
Wageningen University and Research

Freshwater fish diversity reaches its peak in large tropical rivers. Although the origins of this diversity have been relatively well studied, the mechanisms that maintain high fish diversity in tropical rivers remain largely unknown. It has been hypothesized that the annual flood pulse, a perennial feature of many lowland rivers in the tropics, reduces competitive exclusion and consequently promotes species coexistence. During high water, superabundant allochthonous resources and relatively low fish density may reduce intra- and interspecific competition. During the low-water season, resource availability is low and predation pressure high, offsetting competitive differences between species and controlling fish population sizes. We tested the potential role of these mechanisms for species coexistence by building a food web model, where fish species exhibit strong differences in competition strength and compete for finite resources. We found that extinction rates in the simulations without a flood pulse were consistently higher when compared to those with a flood pulse, indicating more species could coexist when a regular annual flood pulse is present. If the flood pulse is a relevant mechanism for fish species coexistence, then flood pulse changes could result in species extinctions and lower fish diversity. Deforestation, climate change, and the construction of large hydropower dams are current drivers of hydrological changes across the tropics, emphasizing the need of understanding the role of natural flooding regimes for the maintenance of tropical freshwater fish diversity and their productivity.

4. Effects of different irrigation techniques on Sphagnum growth and nutrient dynamics in Sphagnum paludiculture

S.A.Käärmelahti, C. Fritz, G.R. Quadra, G. Gaudig, M. Krebs, G. van Dijk, A.H.W. Koks, A.J.P. Smolders, R.J.M. Temmink
Radboud University

Rewetting drained peatlands is crucial for restoring their ecosystem functions, e.g. carbon storage and unique biodiversity. Paludiculture, cultivation of wetland plants on rewetted peatland, such as Sphagnum (peat moss), holds potential for promoting sustainable land use, biodiversity and carbon sequestration.
Sphagnum paludiculture sites require infrastructure for irrigation to keep the water table close to the moss surface. However, there are substantial methane emissions associated with application of conventional ditch irrigation, which calls for improved water management techniques.
Therefore, our study investigated the growth and nutrient dynamics of Sphagnum in a paludiculture setting for three years with four water management techniques: (1) control (ditch distance of 10 m), (2) reduced amount of irrigation ditches (distance 35 m), (3) gravity irrigation with subsurface pipes, and (4) pressurized irrigation with subsurface pipes. After 1,5 years, due to clogging of the subsurface pipes, treatments 2-4 received manual irrigation for the remainder of the experiment.
Our experiment showed that none of the new techniques functioned as well as the control. However, our preliminary results indicate that after three years the fields that started with pressured subsurface irrigation produced the highest amount of biomass and had the lowest probability of P and K limitation.

5. **Acidifying surface water facilitates Sphagnum survival for restoration and paludiculture**

A.H.W. Koks, S.A. Käärmelahti, R.J.M. Temmink, A.J.P. Smolders, B.P van de Riet, L.P.M. Lamers, R.C.J.H. Peters, C. Fritz, G. van Dijk
B-WARE Research Centre/Radboud University

Sphagnum-dominated peatlands are important carbon stores and harbor unique biodiversity. Sphagnum generally occurs in wet and acidic environments. Sphagnum growth is frustrated by well-buffered water sources (high pH and high bicarbonate concentration). One way in overcoming high alkalinity is artificially acidifying surface water. The effects of artificial acidification on Sphagnum growth are however unknown.
We therefore performed a 5-week controlled laboratory experiment where Sphagnum palustre was exposed to two different well-buffered surface water types, which were either acidified or non-treated, in which Sphagnum was emergent or submerged.
Our experiment revealed that Sphagnum survived in acidified or emergent treatments regardless of supplied ion concentration and remained green and vital. Sphagnum submerged in non-acidified water became bleached and chlorotic, and lost substantial amounts of potassium suggesting cell death.
This study highlights that acidification is a potential measure to offset negative effects of pH and bicarbonate on Sphagnum's performance. The high ion concentrations did not prove to be a problem in this experiment on the short term, but should be topic of further investigation. Future research should focus on field trials and large scale application in different regions and surface water types.

6. Macroinvertebrates as redistributors of environmental pollution

Tom van der Meer, Piet Verdonschot, Michiel Kraak
Wageningen University and Research

Macroinvertebrates are key actors in the nutrient dynamics of aquatic ecosystems, detritivorous macroinvertebrates degrade organic matter (OM), while bivalve filterfeeders can remove algae from the water column. Moreover, the burrowing activity of macroinvertebrates affect sediment conditions. As there is an urgent need for new wastewater treatment plant (WWTP) techniques that reduce the amount of sludge produced and lower effluent nutrient concentrations, harnessing the roles macroinvertebrates play in the natural environment could offer a part of the solution. This talk will give an overview of the experiments performed during the 4 years of my PhD-research. The effects of (combinations of) multiple species of macroinvertebrates on the degradation of WWTP sludge, resulting nutrient dynamics and contaminants fate was studied with sludges differing in contamination load. Furthermore the bivalve *D. bugensis* was fed WWTP effluent-cultured algae, to assess the effectiveness of this trophic cascade to remove nutrients and algae. We found that macroinvertebrates increased sludge degradation, and that sludge degradation rate was both dependant on the used (combination of) species and sludge contaminant profile. Macroinvertebrates also affected the redistribution of both nutrients and contaminants during the degradation of sludge. Thus, it is concluded that the treatment of municipal wastewater sludge and effluent by macroinvertebrates is efficient on a small scale, and may be a promising treatment technique to assess on larger scales, to aid in the current challenges that we face with the treatment of our wastewater.

Parallel Session 2

2a: Coastal ecology – Restoration, conservation and management

Conveners: Katrin Rehlmeyer (University of Groningen)
Jon Dickson (Royal Netherlands Institute for Sea Research)

Almost half of the global population lives or recreates in coastal zones; these areas provide a multitude of ecosystem services such as coastal protection, carbon sequestration, food and more. The diverse coastal zones of the world support high biodiversity. Despite their productivity, coastal ecosystems face rapid degradation due to anthropogenic influences and destruction of coastal resources continues. This session focuses on understanding ecosystem functioning, coastal restoration, ongoing threats and holistic coastal management techniques.

1. **Exploring possibilities for subtidal eelgrass restoration in the Dutch Wadden Sea**
Katrin Rehlmeyer, Oscar Franken, Han Olff, Tjisse van der Heide, Laura Govers
University of Groningen

Seagrass degradation is an ongoing problem with meadows disappearing completely in lagoons and estuaries around the globe. Seagrass shoots can ameliorate their habitat through self-facilitating feedbacks by reducing hydrodynamic forcing, and their dense root mats increase sediment stability. As a consequence, seagrass reintroduction can be challenging, as unvegetated systems lack these self-facilitating feedbacks. We therefore aimed to test whether mimicking feedbacks of 1) sediment stabilization with root mimics and 2) hydrodynamic stress relief through underwater sandbag shelters would affect survival of transplanted eelgrass shoots in a field experiment at two potential restoration sites in the Dutch Wadden Sea. Our study indicates that site selection is key for restoration success, that a mechanistic understanding of transplant failures is required before attempting large-scale restoration, and that the reintroduction of self-facilitating feedbacks may benefit short-term survival of seagrass transplants in highly dynamic systems.

2. **Who lives in a pear tree under the sea?**
Jon Dickson, Tjisse van der Heide, Laura Govers, Oscar Franken
University of Groningen

Prior to widescale landscape domestication, downed trees reached the sea in huge numbers; more than five million cubic meters of large wood annually. Some of this wood sank and provided habitat, settlement substrate, nutrients and shelter for various animals. In modern times, this wood flux has greatly declined due to human intervention, decreasing the amount of hard substrate available for marine animals – along with other substrate removal by trawling, deadly shellfish diseases, and active removal. We have created a mimic of this historical marine wood by creating 32 artificial reefs of waste pear trees, each 3m3 in the Wadden Sea to assess their effect on biodiversity and species richness. Within six months, the tree-reefs proved to be hotspots of biodiversity: they were covered in sessile life such as bryozoans, barnacles, tunicates and hydrozoa. Fish abundance was 5x higher within reef areas, with 3x as many species when compared to only-sand control sites. Monitoring 1.5 years after placement revealed fish eggs and juvenile fish within the trees, as well as consistent and regular presence of larger predatory fish and seals. These results indicate that we can rapidly restore degraded soft-bottomed marine systems with active restoration efforts using these 3D biodegradable tree-reefs.

3. **How SANDsitive are seafloor animals in the Wadden Sea?**
Tjitske Kooistra, Rob Witbaard, Tjeerd Bouma, Stuart Pearson, Allert Bijleveld, Tjisse van der Heide, Karline Soetaert
Delft University of Technology/Royal Netherlands Institute for Sea Research

The composition of soft-bottom benthic communities is strongly associated with the sediment they live in. In turn, sediment composition depends on environmental forcing. As such, sea level rise, increased storminess, and changes in sediment supply could drive coarsening of muddy coastal sediments. Species-sediment relations help to predict how this 'sandification' may affect benthic fauna. Here, we explore species-sediment relations for a Wadden Sea tidal basin, with the purpose of quantifying sensitivity of benthic communities to changes in sediment composition. To give a complete view of species' distributions over an environmental variable range, we use non-linear quantile regression models. The top quantiles reflect the optimal habitat, where limitations from other environmental constraints are minimal. Species-specific sediment relations are classified by optima and breadth of the distribution over median grain size and mud content. These parameters are summarised on community level, and the difference between optimal and realised sediment habitat is determined. Overall, the basin is coarser and less muddy than the community prefers. We observe regional mismatches between

community optima and sediment composition, and identify areas where benthic communities may be sensitive to changes in sediment composition. The detailed knowledge of area-specific sensitivity can be used to inform coastal management decisions.

4. **Hotspots in Peril: Identifying mismatches in Seafloor Conservation Prioritization in shallow coastal seas**
Kasper Meijer, Oscar Franken, Sterre Witte, Sander Holthuijsen, Tjisse van der Heide, Laura Govers, Han Olff
University of Groningen

Marine Protected Areas (MPAs) are the most effective conservation measures in protecting and increasing marine ecological value. However, incongruencies between MPA placement and conservation priority areas may arise due to conflicting socio-economic and ecological desires, diminishing the effectiveness of MPAs. The Dutch Wadden Sea is an important intertidal area where macrozoobenthic communities drive ecological processes and form an essential resource for avian and marine predators. A long history of human activity has significantly degraded the system, and several restrictions have been put into place, focusing on protecting shallow and low-dynamic habitats. We present a qualitative and quantitative approach to evaluate the effectiveness of these restricted areas. We conclude that only a fraction of the restricted areas can be classified as an (effective) MPA due to the poor spatial congruence of protection measures and human activities. In addition, we conclude a mismatch between current conservation measures and areas of conservation prioritization based on hotspots of several benthic ecological quality indices. This calls for a reassessment of the current conservation planning and highlights the need for a comprehensive quantitative and qualitative assessment of ecological status in prioritizing new MPAs.

5. **Ridge-runnel patterns as early indicators of tidal ecosystem shifts in estuaries**
Gregory Fivash, Marte Stoorvogel, Jaco de Smit, Floris van Rees, Jeroen van Dalen, Tim Grandjean, Roeland van de Vijsel, Maarten Kleinhans, Maike Heuner, Tjisse van der Heide, Jim van Belzen, Stijn Temmerman, Tjeerd Bouma
Royal Netherlands Institute for Sea Research

Spatial patterns in ecosystems are known to play an important role in maintaining the existing state of a system. However certain patterns also appear to have the capacity to facilitate state transitions. A key example of this phenomenon are the regular 'ridge-runnel' patterns that appear on tidal flats. In this study, we perform geospatial analyses of three European estuaries to demonstrate that the development of ridge-runnel patterns on tidal flats acts as an early indicator of future marsh establishment. Alongside this, a series of field and lab tests explain (1) how and (2) where these patterns tend to form. We find that when cohesive sediment is able to de-water during low tide, it quickly develops an erosion-resistant surface (in a period of hours-to-days). These resistant layers create spatial gradients in erodibility over the tidal flat that lead eventually to the development of ridge-runnel patterns via a scale-dependent feedback process. Regular patterns thereby create a self-sustaining micro-environment where sediment dynamics are suppressed, which improves pioneer seedling survival. These findings demonstrate how ecological transitions can occur as a consequence of geomorphological pattern development; a single case of a phenomenon that is likely to occur more generally across biogeomorphic ecosystems.

6. **Coastal squeeze threatens dune species richness**
Eva Lansu, Hallie Fischman, Christine Angelini, Nadia Hijner, Luc Geelen, Dick Groenendijk, Solveig Höfer, Annemieke Kooijman, Valérie Reijers, Max Rietkerk, Sten Sonkens, Sierd de Vries, Martin Wassen, Evaline van Weerlee, Daniël Wille, Tjisse van der Heide
Royal Netherlands Institute for Sea Research

Coastal dunes form a valuable ecosystem that provides natural flood protection, clean drinking water and home to many unique species. However, infrastructure development and climate change are progressively narrowing the coastal zone globally. Yet, it remains unknown how much space is required to support the diverse habitat and species assemblages found in natural, undisturbed dune systems. Here, we identify vegetation in 711 plots within 12 sea-to-land transects in south-eastern USA and 35 transects in the Netherlands. Our findings reveal a non-linear relationship between coastal width and species richness in both coastal systems. Species richness increases steeply until 1.0 km in south-eastern USA and 1.8 km in the Netherlands, after which the increase of species slows down. At these inflection points, approximately 75% of the species potential is reached. Unfortunately, dunes are narrower than these inflection points along 85% of the south-eastern US and 64% of the Dutch coastline, compromising the systems' potential biodiversity benefits. It is therefore of utmost importance to conserve the remaining dune areas.

2b: Fungal Diversity under Pressure

Conveners: Alena Gsell (Institute of Environmental Sciences, Leiden University)
Emilia Hannula (Institute of Environmental Sciences, Leiden University)
Justin Stewart (Department of Ecological Science, Vrije Universiteit Amsterdam)

Fungi play pivotal roles in terrestrial and aquatic processes such as carbon and nutrient cycling. However, we are still just beginning to understand species and functional diversity of fungi, and how global change affects fungal communities and their interactions with other organisms. In this session we seek contributions on fungal diversity across all habitats, fungal diversity under global change, or approaches on restoring fungal diversity in theoretical or practical examples.

1. Fungal involvement on organic matter deposition on the smallest aggregate fraction

Elly Morriën, Nan Zhang, Julia Averkamp, Steven de Goede, Anna Clocchiatti, Emilia Hannula, Boris Jansen
University of Amsterdam

Soils have an enormous potential to store carbon to mitigate climate change. Net carbon storage depends on more organic carbon entering soil than being respired. The challenge is to activate those microbes involved in soil aggregate formation and decelerate activity of others. Organic carbon occluded in aggregates is physically protected from further degradation if these aggregates are stable. My research aims to unravel how carbon ends up in aggregates and how this is mediated by microbes and particularly fungi. We discovered that fungi are the initiators of a tighter connected soil food web which restores the closed carbon and nutrients cycles in soils, thereby accommodating species-rich plant communities in grasslands. Boosting the fungal channel as a bottom-up approach could thus be used as a next-generation restoration measure. We show data of soil inoculation experiments and trace the progression of change in the fungal community via sequencing and functioning via community response profiles. We think that soil fungi may play an important role in storing more carbon in soils for longer periods of time. We can also show data that steering on microbial activity on small soil particle size leads to more stabilized mineral associated organic matter, which is the most stable form of organic carbon.

2. Climate and landuse jointly shape arbuscular mycorrhizal fungal biodiversity loss in a tropical mountain ecosystem

Justin Stewart
Vrije Universiteit Amsterdam

Landuse change is the global primary threat to biodiversity loss in terrestrial ecosystems. Specifically, tropical mountains host some of the most biodiverse ecosystems on Earth and are particularly threatened with biodiversity loss due to landuse change. This is largely attributed to land with native vegetation being increasingly converted into agricultural fields as human settlements expand to higher elevations up mountains. Arbuscular mycorrhizal fungi (AMF) are a group of soil microbes that live in symbiosis with most terrestrial plants (> 70%), play crucial role in ecosystem processes and plant community assembly but are often overlooked in studies of tropical biodiversity. Here we sampled AMF communities across an ~1600m elevation gradient in native vegetation and adjacent monoculture farms. We found that conversion to farmland reduced AMF richness but this varied across precipitation and temperature gradients. Fungi in cold-dry habitats were most vulnerable to landuse change. These findings can help guide biodiversity protection frameworks by putting the communities of AMF most at risk to species loss on the map.

3. Stronger decrease in ectomycorrhizal vs total fungal biomass with tree harvest intensity

Steven de Goede
Netherlands Institute of Ecology

Forest management has been identified as an important tool to mitigate climate change through storing carbon in trees and soils. Yet, relatively little is known about how different harvest intensities affect soils and their carbon cycling. Ectomycorrhizal fungi (EcM) play a major role in soil organic carbon stabilization in European forests, and are likely strongly decreased in abundance by tree harvesting. This negative impact may be reduced by only lightly reducing tree stand density through thinning instead of clearcutting. Here, we studied how harvest intensity affects fungal biomass and community composition, zooming in on EcM versus saprotrophic fungi. Method: In 15 Dutch 1-ha forest stands (covering European beech, Douglas fir and Scots pine) located on poor sandy soils, four different tree harvest intensity treatments were applied: 0%, 20%, 80%, and 100% of biomass harvested. We used fungal in-growth bags to determine EcM biomass with ergosterol. From bulk soil samples we measured total fungal biomass and inferred saprotrophic biomass. Relative abundance of fungal groups has also been assessed

via ITS2 metabarcoding. Results: Both EcM and total fungal biomass decreased with harvest intensity, although the response for 20% and 80% thinning is relatively small. However, we observe more pronounced effects near removed trees compared to remaining trees after harvest. Clearcutting showed a clear reduction in fungal biomass, but significantly stronger for EcM. These effects are more distinct for Scots pine and European beech than for Douglas fir. Conclusions: Tree harvesting leads to a loss of EcM fungal biomass which may lower rates of soil organic carbon stabilization, but this can be minimized by applying low-intensity forest thinning.

4. Impoverishment of plant-fungi co-occurrence networks in mountains through roadside disturbance

Dajana Radujkovic
University of Antwerp

Roads are currently one of the most disruptive anthropogenic disturbances to mountain ecosystems worldwide. While the effects of roadsides on surrounding vegetation are well-documented, their impact on plant-associated fungal communities and interactions remains unclear. Our study explores plant-fungal and fungal-fungal association networks along mountain roads across four biogeographical regions. We found that roadsides consistently reduced the complexity and altered the structure of both positive and negative plant-fungal and fungal-fungal association networks along the elevation gradients. These changes were more pronounced and more consistent across regions than the changes in plant and fungal diversity and community composition. Our findings suggest that modified and impoverished plant-fungal and fungal-fungal networks are a reliable indicator of roadside effects that could not be easily detected by examining plant community composition alone. These changes in network complexity may ultimately help understand species distributional shifts along roads, being the most prominent dispersal corridors in mountain ecosystems.

5. The effects of changing temperatures on diatom-chytrid dynamics and carbon fluxes to lake sediments

Lisa Morales, Grace Kotnik
University of Geneva

Asterionella formosa is a large, common diatom species that dominates spring blooms in many temperate lakes worldwide. These blooms are often terminated by a fungal parasite, the chytrid *Zygorhizidium*. Consequently, this host-parasite interaction shifts phytoplankton community composition and likely affects the amount of carbon exported to lake sediments in spring. Increasing temperatures are likely to alter this interaction. In a typical cold winter, *Zygorhizidium* is present as inactive resting spores. This allows *Asterionella* a window of unimpeded growth during the winter- spring transition, leading to the formation of a spring diatom bloom. Once the chytrid resting spores hatch, they rapidly infect *Asterionella* cells and increase in abundance until they kill the bloom. In contrast, warmer winters allow *Zygorhizidium* to maintain infections over winter, preventing *Asterionella* from increasing in abundance and forming a bloom. This shifts the community composition, which alters both lake food webs and carbon fluxes.

Our work attempts to understand how a changing abiotic environment (temperature) affects a complex ecological interaction (parasitism) to ultimately alter a globally important ecosystem parameter (carbon flux). It will develop a fundamental theoretical and empirical understanding of the temperature-dependence of host-parasite interactions, while addressing the consequences of environmental change for ecosystem processes.

6. Transparent soil: promising novel technique to revolutionize the cultivation of AM fungi

Malin Klein
Vrije Universiteit Amsterdam

Arbuscular mycorrhizal fungi (AMF) form symbioses with the majority of terrestrial plants and are key players in plant nutrient acquisition. While the interactions of plants and AMF are well-studied, the diversity of AMF mycelial network architecture is under-represented. As the specific network structure (i.e., density, branching, interconnectedness, length, …) may provide crucial insight in the network's resilience and efficiency of the fungal partner, this is undoubtedly an important research focus.
An omnipresent challenge in AMF research is the culturing of this obligate biotroph under controlled experiment conditions. Although co-culturing both partners in natural soils may be closest to reality, the observation and analysis of the mycelial development in this setup is impossible. To investigate mycelial architecture, the preferred method is in vitro co-cultivation with (non-photosynthetic) root organ cultures. However, this is only possible for a small fraction of AMF species. By using a promising novel, non-sterile technique, 'transparent soils', we aim to investigate the network diversity of less frequently studied AMF species due to their incompatibility with in vitro conditions. Transparent soils make use of a super-absorbent, yet fully transparent granular polymer that can mimic certain soil properties, so that this setup is compatible with whole plants.

2c: Bending the curve using theoretical ecology

Conveners : Monique de Jager (Utrecht University)

There is a need for understanding the patterns and processes of ecosystem recovery; ideally, we can improve the speed, magnitude, and efficiency of ecosystem recovery by means of a general theoretical framework to guide restoration practices. In this session, we highlight theoretical approaches that can help to inhibit biodiversity decline and perhaps even bend the curve.

1. Can estuarine ecosystems adapt to climate change?

Johan van de Koppel
Royal Netherlands Institute for Sea Research

Understanding how ecosystems can persist under increasing environmental stress in times of global change is crucial to maintain biodiversity as well as valuable ecosystem services. Conservation and restoration projects often project benefits for ecosystem resilience, but whether and how this is accomplished is not always understood. Using examples from estuaries, I discuss how spatial adaptation of ecosystems, in terms of self-organisation processes adjusting the landscape to changing conditions, can play a crucial role in maintaining ecosystem functioning. Models of self-organisation highlight that spatial adaptation affects resilience to sea level rise and salt intrusion, but this can be either beneficial or detrimental. Finally, I discuss approaches to overcome societal thresholds using visual models of estuarine ecosystems.

2. A population-dynamical model to optimise agricultural landscape management for natural pest control

Laura Mansier
University of Amsterdam

Pest-regulating insects often require habitats other than crop fields to persist and be effective. These habitats can e.g. provide hibernation sites, alternative prey, or floral resources. Landscape based population-dynamical modelling can give more insight in the relative importance of these different habitats for the performance of pest-regulating insects.
In this study, we modelled the dynamics of predatory hoverflies (Diptera: Syrphidae) and their aphid prey in a collection of habitats. These hoverflies are dependent on different habitats for different reasons. Whilst their larvae feed on aphids, adult hoverflies require floral resources. Both types of resources are often spatially segregated in agricultural landscapes. In addition, these resources are often only temporarily available in one habitat, so that multiple habitats are required to cover the annual cycle of a hoverfly population. In our model, hoverflies can move between different habitats and select where to feed and where to produce off-spring based on optimal foraging considerations. The model represents habitats common in arable landscapes and is parameterised based on field observations of temporal and habitat-related availability of resources. This model is unique as it combines predator-prey interactions, developmental delays, detailed seasonal forcing and habitat structure.
Our model indicated that optimal hoverfly performance and aphid suppression require a minimum of three different habitats offering resources at different times of the year. A woody habitat with shrubs and trees provide aphids very early in the season, whereas an early crop and a late crop cover the period in between. Model analyses show that different arable crops enhance each other's pest control when their aphid populations peak at different times of the year. In addition, these habitats need to provide floral resources simultaneously with the aphids, e.g. in a flowering sub-habitat such as (wild)flower margins.

3. Quantifying the relative contribution of selection, dispersal and stochastic processes to local community assembly

Jelyn Gerkema
Utrecht University

Understanding how local plant communities are assembled still proves to be challenging. Although the general mechanisms (i.e., selection, dispersal, and stochastic processes) are well understood, their relative contribution on a local scale is often much harder to quantify. The CATS (Community Assembly via Trait Selection) model was designed to quantify the relative importance of these processes. As a maximum entropy model, its mathematical foundations lie in information theory. It is therefore able to analyse data without introducing any additional bias or assumptions. In the past, the model has yielded promising results. Nonetheless, questions regarding its limitations and the impact of data quality still remain. In our study, we will assess the generalizability of the model across taxonomic scales and gradients of biodiversity, by analysing data on functional trait values and community composition from published, open access studies spanning multiple continents and a wide range of habitats. We will determine if and when the usage of CATS is appropriate, and in doing so, will hopefully gain a better

understanding of the drivers behind biodiversity. This knowledge could prove invaluable for conservation and restoration efforts.

4. Speciation in a MacArthur model: a numerical approach

Joshua Dijksman
University of Amsterdam

Ecosystem dynamics is often considered driven by a coupling of species' resource consumption and its population size dynamics. Such resource-population dynamics is captured by MacArthur-type models. One biologically relevant feature that would also need to be captured by such models is the introduction of new and different species. Speciation introduces a stochastic component in the otherwise deterministic MacArthur theory. We will discuss how speciation can be implemented to yield a model that is consistent with current theory on equilibrium resource-consumer models, but also displays readily observable rank diversity metric changes. The model also reproduces a priority effect. Adding speciation to a MacArthur-style model provides an attractively simple extension to explore the rich dynamics in evolving ecosystems.

5. A joint model for estimating species distributions and environmental characteristics from point-referenced data

Markus Viljanen, Lisa Tostrams, Niels Schoffelen, Jan van de Kassteele, Leon Marshall, Merijn Moens, Wouter Beukema, Wieger Wamelink
National Institute for Public Health and the Environment

Species Distribution Models (SDMs) are important statistical tools in ecology to predict and explain species occurrence using environmental characteristics. In nature conservation they can be used to spot opportunities for biodiversity reconstruction. However, environmental input data in SDMs is often predicted from other models, measured with error, or interpolated from measurement points. This means that independent variables in a statistical model are not known for certain at every location, which compromises SDM interpretation.
We propose a solution to this problem by a hierarchical Bayes model, where models for environmental variables are input to the SDM. All models are fitted jointly to real data that consists of only limited field visit locations. This means the uncertainty of environmental variables is correctly taken into account, which is not the case in standard approaches. We applied this new approach on Netherlands Flora Monitoring data (LMF) and compared this with the standard approach. Predicted occurrence maps are close to identical but the new approach is more accurate for some rare species and consistently delivers different associations with abiotic factors.

6. Decline of shorebirds: a matrix population model for the semipalmated sandpiper

Lia Hemerik, Ron Ydenberg
Wageningen University and Research

Matrix population models can be of great use in conservation strategies for threatened species. From these models, that are based on demographic data (survival and reproduction), we can infer the yearly population growth factor (λ, the dominant eigenvalue of the matrix).
Large population declines have been reported over recent decades for *Calidris pusilla*, or semipalmated sandpipers, a species mainly occurring in North America as well as for other shorebird species. Individuals in some Arctic-breeding shorebird species 'over-summer' - i.e. they skip migration and breeding altogether and remain on or near non-breeding areas instead. The 'seasonal' survival probability (thus from April – September) of over-summering individuals is higher than for migrants. This over-summering has recently increased and seems an evolved life-history adaptation.
Here, a stage-structured matrix population model that incorporates over-summering is developed for *C. pusilla*. With this model we show that the substantial decline in numbers can be largely explained by an increase of over-summering. We give the predicted mean and median time for a 50% reduction of the population in a deterministic and stochastic version of the model.

2d: Global change impacts on ecosystem functioning

Conveners: Justine Lejoly (Netherlands Institute of Ecology)
Mariana Gliesch Silva (University of Amsterdam)
Alix Vidal (Wageningen University and Research)
Dina in 't Zandt (Netherlands Institute of Ecology)
Rutger Wilschut (Wageningen University and Research)

In a rapidly changing world, biodiversity loss is threatening ecosystem functioning. Global change alters a myriad of above-belowground interactions involving plants, biota and soil biogeochemistry. To predict ecosystem changes and protect ecosystem functioning, it is crucial to understand how global change affects aboveground and belowground interactions. We welcome contributions exploring global change effects on different ecosystem functions above- and belowground. We particularly seek studies linking biodiversity and soil biogeochemistry, and interactions between plants and their associated above- and belowground biota.

1. Soil biodiversity-ecosystem functioning (sBEF) relationships depend on global change drivers

Alejandro Berlinches de Gea
Wageningen University and Research

The relationship between biodiversity and ecosystem functioning (BEF) is well-established for plants with positive common links shown for plant diversity and ecosystem functions. These BEF relationships have been shown under ambient conditions and different global change factors such as in distinct climate conditions (e.g. drought) and management forms (e.g. nitrogen addition). However, the BEF relationship is barely known in soils (sBEF), the world's most diverse ecosystems hosting ≈59% of the total known diversity on Earth. The impact of cooccurring global change drivers (GCDs) on this sBEF relationship is even less known. In two greenhouse experiments, we used protists as models for soil biodiversity to investigate the effect of increasing protist diversity (from 0 to 30 species) on plant biomass (*Solanum lycopersicum* and *Cannabis sativa*) and nutrient cycling. We showed that sBEF patterns were not only positive (up to 23% biomass increase under nematode infection) but could also be negative (up to 39% biomass loss under drought). Similarly, increasing biodiversity did not consistently increase plant biomass, but led to a similar plant biomass in 25, 100 and 150 kg N ha-1 year-1 treatments. Combined stressors exhibited additive patterns, cancelling out individual GCD effects. These results challenge existing claims about (s)BEF relationships, emphasizing that (s)BEF patterns might be biased as they depend on external conditions, the organismal group studied, or even the GCD(s) tested.

2. What is driving grassland plant-soil feedback under drought?

Eileen Enderle, Fangbin Hou, Leo Hinojosa, Mariana Gliesch, Franciska De Vries
University of Amsterdam

Extreme drought events in grasslands have indirect effects on plant growth that are mediated by the soil microbial community, thus potentially affecting plant-soil feedbacks (PSF). This may be caused by differences in plant inputs into the soil such as rhizodeposits. In a modified version of a classic plant-soil feedback experiment we investigated how drought-induced changes in root litter and exudates drive PSF and plant growth, using three common grassland species. In soil conditioned by plants growing in it, we found that previous drought negatively affected biomass production of subsequently grown plants, which was related to a decrease in soil microbial biomass. PSF was species-specific and generally negative but unaffected by drought. Soils conditioned by root litter and exudates from droughted plants did not show the same pattern of plant growth and PSF and their microbial communities differed from plant-conditioned soils. Our results show that root exudates or root litter alone cannot explain plant-soil feedback under drought and non-drought conditions.

3. Next-Gen Restoration: Soil biodiversity and evaluating ecosystem recovery in temperate woodlands

Giles Ross
Netherlands Institute of Ecology

Land-use is known to severely reduce aboveground plant diversity and measures of soil functioning, yet the impact to belowground biodiversity is less clear. Using high-throughput sequencing we detail communities of fungal (ITS), bacterial (16S), and microarthropod oribatid mites (COI) in sites that span a restoration gradient. Samples were taken from eight restored and four degraded sites of "threatened" Cumberland Plain Woodlands (CPW) in NSW, Australia. Temperate woodland ecosystems included short-term actively and long-term passively restored sites. High-throughput sequencing (HTS) outputs indicated that soil microbiome and microarthropod compositions could be linked to improved

aboveground vegetation and litter decomposition whilst also associated with higher rates of ecosystem functioning, via nutrient bioavailability. Indicator fungal families linked to positive metrics of ecosystem functioning (e.g. litter decomposition, nutrient turnover) included AMF species and bacterial classes of Acidobacteria, Beta and Delta/Proteobacteria highlight biodiversity targets for focussed ecosystem recovery and monitoring programs. Additionally, oribatid mites of the Nothrus family may be early indicators of successful recovery. These findings indicate the potential for HTS to target restoration and monitoring efforts to focus restoration practices across all ecosystem types.

4. Assessing the effect management intensity and increased soil microbial biodiversity on the soil agro-ecological functioning

Rosa Boone, Bjorn Robroek, Wim van der Putten, Hans de Kroon
Radboud University

Transitioning to sustainable agriculture can be made easier by improving our understanding of the relationship between Land Use Intensity (LUI), soil microbial biodiversity, and soil functioning. By implementing more extensive agricultural practices, we can enhance soil functioning, which may be influenced by changes in the microbial community. However, we still have limited knowledge of how these three factors are connected in real-world grassland environments. In our study, we will examine the composition of fungal and bacterial communities in soils from 18 grasslands with varying levels of LUI, ranging from conventional to semi-natural, in the Ooijpolder, Nijmegen. We will also assess soil nutrient functioning using different methods, including enzymatic assays, Microresp analysis, and Teabag analysis. Additionally, we will use a Structural Equation Model to understand how LUI affects soil nutrient functioning and how this relationship is influenced by changes in the microbial community. By integrating these three concepts, we aim to gain insights into the specific dynamics of each context, which can inform decision-making for transitioning to sustainable agricultural practices. As an initial finding, we observed a strong correlation between the composition of the fungal community and the LUI gradient.

5. Contribution of agricultural fields for conservation of arthropod populations

Iryna Litovska, Fons van der Plas, David Kleijn
Wageningen University and Research

The intensification of agriculture has been identified as one of the main causes of arthropod declines. To reverse this, changes in farming practices and management of surrounding habitats should occur, but a key challenge is identifying which changes in management approaches are effective in restoring biodiversity. Therefore, this study examines arthropod abundance and diversity in different agricultural habitats and management types. Arthropods were sampled three times in spring and summer of 2022 with pyramid traps in 120 sites in Buijtenland van Rhoon (Netherlands). These sites included a variety of crops as well as semi-natural habitats. Our study showed that on average the abundance and diversity of arthropods of several taxa was lower in crop fields compared to semi-natural habitats. Interestingly, in crop fields most variables related to field management, such as herbicide applications, amount of fertilizer usage and days after ploughing did not show any significant relationship with arthropod abundance or diversity. Within semi-natural habitats, number of days after mowing was positively related to arthropod abundance of several taxa and Hemiptera family diversity. Overall, our findings show that some crop species can strongly contribute to arthropod abundance and diversity, while management was only related to arthropod communities within semi-natural habitats.

6. Can earthworms thrive and influence rock weathering in an artificial organo-mineral system?

Tullia Calogiuri, Iris Janssens, Alix Vidal, Jan Willem van Groenigen, Thomas Corbett, Harun Niron, Reinaldy Poetra, Lukas Rieder, Abhijeet Singh, Sara Vicca, Mathilde Hagens
Wageningen University and Research

Enhanced Silicate Weathering (ESW) is a promising Carbon Dioxide Removal (CDR) technology, but the biotic factors maximizing its effectiveness remain unclear. Earthworms could amplify mineral weathering rates, yet under which conditions is unknown. Here, we aim at 1) identifying optimal conditions for earthworms in an artificial organo-mineral system, and 2) determining the effect of earthworms on commonly used weathering indicators. We conducted seven rounds of eight-week experiments, using two endogeic earthworm species (*Aporrectodea caliginosa* and *Allolobophora chlorotica*) at three densities, four rock flours in two grain sizes, two organic substrates, addition of biochar and enzymes, and three water irrigation rates at three frequencies. At the end of each round, we measured earthworm survival and activity, and commonly used weathering indicators, such as dissolved inorganic carbon (DIC) and total alkalinity (TA). Amongst all factors considered, we found that survival and activity were mainly driven by variables influencing the structure of the organo-mineral mixture, such as rock grain size and type. While we could not find a significant overall earthworm effect, isolating treatments with alive and dead earthworms gave distinct results. On one hand, alive earthworms had a null or negative effect on weathering indicators, probably due to an increase in organic matter protection, with organic carbon being the main driver in DIC changes. On the other hand, dead earthworms increased almost all weathering indicators due to a series of possible mechanisms, e.g. enhanced microbial activity and diversity. Due to different ways in assessing biotic drivers in mineral weathering, a standardization of indicators aimed at detecting the effect of earthworms on mineral weathering is urgently needed.

Parallel Session 3

3a: Parallel 3a: A non-toxic environment to protect biodiversity

Conveners: Annemarie van Wezel (University of Amsterdam)
Paul van den Brink (Wageningen University and Research)

All those chemicals in our waters and soils, how do they affect biodiversity? And how important is it to stronger connect the research communities on environmental chemistry and toxicology to those on ecology, evolutionary biology and biodiversity? This session will provide some prime examples on modelling, mesocosm and field work that provides a better understanding on the relevance of chemical pressures for bending the curve for biodiversity, and what can be solutions to lower these pressures.

1. Effects of global change on the emission, fate, effects and risks of chemicals in aquatic ecosystems

Paul van den Brink, Annemarie van Wezel
Wageningen University and Research

The ECORISK2050 project (www.ecorisk2050.eu) was initiated with support from the European Union Horizon 2020 program to support the European Union goal of a non-toxic environment by 2050. Taking a holistic approach to address the many challenges in chemical risk assessment under global change, ECORISK2050 brought together an interdisciplinary team of experts in global change, scenario development, environmental modelling, environmental chemistry, exposure assessment, ecology, ecotoxicology and risk assessment, as well as intersectoral input from academic beneficiaries and key stakeholders from the chemical industry and regulatory sectors. The aim of this presentation is to show key issues related to the implication of global change on the risks of chemical residues in the environment investigated by the ECORISK2050 project, and the methodologies employed and project outcomes. The ECORISK2050 project concludes that scenario-based forecasting of chemical exposure to pesticides and pharmaceuticals is possible when sufficient data are available. The fate and effects of the chemicals are altered by changes in use and temperature, but not always in the same way, it is context specific. Future risks can be mitigated by changes in behaviour (e.g. plant based diet) and substitution of chemicals by safer alternatives.

2. Assessing the behavioural sensitivity of Gammaridae to pesticides and pharmaceuticals

Elien Versteegen, Edwin Peeters, Ivo Roessink and Paul van den Brink
Wageningen University and Research

Freshwater systems are continually exposed to various was streams, including municipal wastewater and agricultural runoff. Pollutants in the aquatic environments might change the behaviour of animals. Gammaridae are essential in marine and freshwater ecosystems as both decomposers, prey, and predators. Changes in their behaviour as a result of environmental pollution, may impact their ecological roles. In this study, we aim to provide more insight in whether behavioural responses are potentially reliable forebodes for toxic effects in our aquatic environments. Therefore, we evaluate *Gammarus pulex* swimming activity as an endpoint compared to mortality and immobility for compounds with different modes of action. To understand the importance of behavioural endpoints, the laboratory behaviour studies will be compared with behaviour tests performed in mesocosm experiments. In four laboratory experiments, we exposed the *G. pulex* to different compounds (two pesticides: imidacloprid and chlorpyrifos, and two pharmaceuticals: carbamazepine (CBZ) and citalopram (CIT)) with different modes of action. After 48-h of exposure, the dead and immobile organisms are counted, and the swimming activity of all mobile organisms was individually assessed. Two mesocosm experiments study the effect of chronic exposure to CBZ and CIT on *G. pulex* behaviour and population. Unlike expected, behavioural endpoints are not always more sensitive than mortality and immobility. All four compounds tested in the laboratory had different sensitivity ratios. And while acute laboratory studies found effects of CIT (2mg/L) and CBZ (4.6 mg/L), chronic exposure to environmentally relevant concentrations of CIT and CBZ do not show effects on population level in mesocosm studies. The behavioural endpoints are therefore not a reliable forbode of lethal effects, but the found effects can provide more insight in the mode of action of these compounds in *G. pulex*.

3. **Physiological and behavioral responses of blue mussels to chemicals leaching from offshore wind turbine coatings**
Katharina Alter, M. Ndugwa, M. Daliri, A. Booth and L. Sørensen
Royal Netherlands Institute for Sea Research

Offshore wind farms (OWFs) contribute to the epibenthic biodiversity in the North Sea, but do they also offer a healthy environment? The coatings used to protect submerged OWF infrastructure may leach potentially harmful chemicals. These chemical emissions may negatively affect marine biota, such as blue mussels (Mytilus edulis), which act as important habitat builders for the local biological hotspots. Mussels are routinely used as early warning signals to detect changes in water quality. Using technology that monitors the valve gape behavior, valve closure can alert us to chemical pollution. We used such valve gape, as well as heart rate sensors, to test whether exposure to coatings in OWFs leads to changes in behavior and physiology of adult blue mussels in a two week laboratory experiment at stable thermal conditions followed by a temperature challenge trial to assess potential constraints in their performance. A non-targeted screen approach (two-dimensional gas chromatography coupled with high-resolution mass spectrometry analysis), of the coating-exposed seawater revealed a number of chemicals in the leachates. Blue mussels exposed to these leachates had a reduced valve gape for longer periods of time and had higher heart rates, but did not show differences in performance when compared to animals kept in control conditions. Growth experiments should be conducted to determine if the observed differences in valve gape and heart rate lead to long-term reduction in performance. Additionally, tests on species commonly associated with mussel beds, as well as earlier life-stages, can reveal if species communities found in OWFs are constrained by the chemical leachates deriving from used coatings.

4. **Can strip cropping enhance pest management and biodiversity?**
Luuk Croijmans, Dirk van Apeldoorn, Felix Bianchi and Erik Poelman
Wageningen University and research

Chemical pesticides are still a staple in pest management of agricultural systems, yet sustainable alternatives to pesticides need to be developed. One such alternative measure is strip cropping, where crops are grown in narrow strips to facilitate both ecological interactions between crops and current intensive agricultural practices. Over the course of four years, we have studied whether strip cropping can enhance pest management and biodiversity. We found that strip cropping enhances parasitism rates by parasitic wasps, and reduce the survival of herbivores. Also, strip cropped fields had on average 15% more ground beetle species than monocultural fields. Interestingly, we observed certain nuances and differences from theories on the effect of habitat heterogeneity on herbivore abundances. For example, whereas we surprisingly found higher oviposition of the cabbage root fly on cabbages in strip cropping, we did not observe any difference in the number of larvae later in the season. This indicates that survival of root fly immatures is lower in strip cropping, and that egg numbers might not be good predictors of crop damage in more diverse cropping system. Similarly, we observed that the effect that aboveground herbivores have on crop production differ among cropping strategies. This new ecological reality means that economic thresholds based on herbivore numbers might not be representative for crop damage in more diverse cropping systems.

5. **The long-term ecological effects of single antibiotics and their mixtures on freshwater ecosystems**
Dailing Wu, Kaisheng Yao, Markus Hermann and Paul Van den Brink
Wageningen University and Research

The wide and large use of antibiotics all over the world increased the residue concentrations of antibiotics in environments, where the organisms are exposed continuously to multiple antibiotics. However, the knowledge about the effects of chronic exposure of antibiotics on aquatic ecosystems and the effects of their mixtures is sparse. Hence, in this study, we conducted an indoor microcosm experiment to mimic real aquatic ecosystems to investigate the effects of long-term exposure to antibiotics on aquatic ecosystems. Sulfamethazine (SMT) and tetracycline (TC) were selected as representative antibiotics which were applied to tested microcosms with different concentrations (SMT: 0.1 ug/L, 1.0 ug/L and 10 ug/L; TC: 1.5 ug/L, 15 ug/L and 150 ug/L) and combinations. After 28 days (4 weeks) of exposure, the results showed that the concentration of green algae was lower in the two higher concentration treatments of both STM and TC compared to the control until the end of the experiment while no significant difference between the different treatments was observed in the mixture treatments. For the zooplankton community, their abundance and diversity were significantly affected by the antibiotics and their mixture. The total abundance of zooplankton in all highest concentrations of three different treatments (SMT, TC and mixture) increased substantially in the first 7 days or first 14 days, followed by a decrease until the end of the experiment. Moreover, the microbial degradation didn't present significant differences in the first 14 days but showed significant effects of the treatments after 28 days of exposure. The abundance of macroinvertebrates (*Asellus aquaticus*, *Gammarus pulex*, *Physella* sp. and *Planorbis* sp.) didn't show a clear significant treatment related difference during the experiment period but the food consumption by them indicated that in the SMT treatments food consumption was

higher in the highest concentration (10 ug/L) than that in the lowest concentration (0.1 ug/L) ($p < 0.05$). The results from this study showed that the selected antibiotics pose long-term effects on aquatic ecosystems, and The mixture of the antibiotics resulted in different effects than the individual antibiotics, which will be studied in more detail the coming months.

6. Fate and ecotoxicological impact of contaminants of emerging concern in the Dutch Wadden Sea Area

Olga Bernadet
Royal Netherlands Institute for Sea Research

Coastal systems play an important role in land-to-ocean transport of matter, including contaminants of emerging concern (CECs). CECs refer to novel contaminants only recently detected in water that are of concern due to limited knowledge of their behaviors and risks. Although commonly found in low concentrations (i.e., ng L-1 to µg L-1), CECs are biologically active, can be bioaccumulated, and are potentially harmful to humans and the environment. The Wadden Sea is a UNESCO-protected intertidal area stretching from The Netherlands to Denmark. It receives anthropogenic input from Dutch, Danish, and German rivers and lakes and is in continuous exchange with the North Sea. The amounts of legacy contaminants such as metals, polychlorinated biphenyls, organochlorine, and lindane, entering and retained in the Wadden Sea are known. However, information on the concentration and ecotoxic effects of CECs, like pharmaceuticals, which also enter the Wadden Sea area via the discharge of wastewater treatment plants (WWTPs) effluents, is limited. In our study, we used a combination of solid-phase extraction and liquid chromatography time-of-flight mass spectrometry (LC-TOF/MS) to determine the CEC concentrations in the WWTP effluent and the receiving seawater. A combination of solid-liquid extraction and LC-TOF/MS was also used to determine CEC concentrations in the suspended particle and the sediment. Passive sampling was applied to extract bioavailable CECs prior to in vitro and in vivo ecotoxicity assay. The results provide insight into the occurrence, load, exposure, and ecotoxic effects of CECs in the Wadden Sea and the associated benthic macrofauna.

3b: Predator ecology - monitoring, impact and conservation.

Conveners: Esther Swankhuisen (University of Groningen)
Pieter Otte (University of Groningen)

Many changes are occurring amongst predators: some examples are the return of wolves and golden jackals in Europe, the unknown conservation status and decline of mustelids in the Netherlands, and the growing recognition of domestic cats as invasive species worldwide. These changes lead to heated debates in society. In this session, we explore important research questions: How do we effectively monitor predator species? What roles do they play within ecosystems? And, what long-term conservation measures should we take?

1. **Prey tracking and predator avoidance in tropical forest mammals: a camera-trapping approach**
Patrick Jansen, Constant Swinkels, Jessica van der Wal, Christina Stinn, Claudio Monteza-Moreno
Wageningen University and Research

Predator-prey interactions are difficult to study, especially in forest mammals. A common approach to study these interactions among mammals is to monitor the spatial proximity of animals at fixed times, using GPS tags fitted to individuals. We used an alternative, non-invasive camera-trapping approach to monitor temporal proximity of predator and prey animals. We deployed camera trapsat30fixed locations across Barro Colorado Island, Panama, where the ocelot (*Leopardus pardalis*) is the principal mammalian predator ,and tested two hypotheses: (1) prey animals avoid ocelots; and (2) ocelots track prey. We quantified temporal proximity by fitting parametric survival models to the time intervals between subsequent captures by camera traps, and then compared the observed intervals to random permutations that retained the spatiotemporal distribution of animal activity. We found that time until a prey animal appeared at a location was significantly longer than expected by chance if an ocelot had passed (i.e., predator avoidance), and that the time until an ocelot appeared at a location was significantly shorter than expected by chance after prey passage, (i.e., prey tracking). This demonstrates that camera trapping is a viable and non-invasive alternative to GPS tracking for studying certain predator–prey interactions.

2. **Habitat selection of a threatened felid in a human-dominated landscape: an imperative study on cheetah in southern Africa**
Nynke Wemer, Allison Muller, Vincent Naude, Alison Leslie, Jan Komdeur, Marna Smit
University of Groningen

Urbanization often triggers habitat loss and fragmentation, driving species toward extinction. Large carnivores, particularly those with extensive home ranges and slow reproductive rates, suffer significantly from anthropogenic pressure. A quarter of global carnivores face extinction or have disappeared since the 1970s, with carnivores like the cheetah now only residing in 9% of their distributional range. With only 7,100 individuals left globally, mainly in southern Africa, cheetahs play a crucial role in carnivore conservation. Assessing cheetah numbers, growth, and declines becomes pivotal for their survival. Most free-roaming cheetah are distributed outside of PAs in southern Africa, despite increasing anthropogenic land use, resulting in competition for space between cheetah and farmers. We predict that the growth in human activity has caused an increase in HCC likelihood with higher cheetah distribution and presence predicted on farmlands with domestic livestock or game compared to exclusively agricultural lands. A Habitat Suitability Species Distribution Model (HSSDM) will be used to map current free-roaming cheetah distribution as well as determine any habitat losses and gains over the years and how much of the habitat gain is man-made (i.e. PAs). Additionally, the HSSDM can inform us of possible areas where HCC can arise.

3. **Wild cat in the Netherlands**
Bram Houben
ARK Rewilding Nederland

The European wildcat population in the Netherlands is increasing, especially in the region of the three countries park. In the Euregio Meuse-Rhine is wildlife coming back, among which the wildcat that disperses mainly from German population further north towards the Netherlands.
ARK Rewilding Nederland has two projects to specifically improve corridors and nature areas. One project is financed by the province of Limburg and one by the province of Brabant. Both projects are complementary towards each other.
Concrete actions of these projects are the following: realisation of corridors, realisation of suitable habitat, monitoring, communication and cross border cooperation.

During this presentation we will explain the measurements we are taking in the field. And what kind of 'rewilding' actions you can take to improve the habitat of the wild cat by increasing the biodiversity in our nature areas.

4. Mustelid Mugshots: Monitoring the smallest carnivores with camera traps

Tim Hofmeester
Swedish University of Agricultural Sciences

Small carnivores, especially small mustelids (members of the Mustelidae), play an important role in ecosystems as predators of rodents. However, due to their small size and generally low population densities, they are hard to observe. There is thus a lack of monitoring data for these smallest of carnivores, while the little data that we do have suggests that populations are declining over large parts of their range. Recent advances in camera trapping, cameras that are activated by a passive infrared sensor, have led to promising tools for monitoring small mammals, including small mustelids. In this talk, I will present two such tools, the Mostela system and the Polecam. Both systems allow the camera trap to be positioned in locations that are used by small mustelids where regular camera trapping would be infeasible, such as within dense vegetation. Using data from field studies in Sweden, Poland and the Netherlands, I will show how to obtain occurrence and (relative) density estimates of weasel (*Mustela nivalis*) and European polecat (*Mustela putorius*) with these camera-trapping systems. Due to their versatility, these camera systems show great promise as a cost-efficient and scalable monitoring method for small mustelids.

***5.* Feral cat farewells: the effectiveness of removing feral cats from the island of Schiermonnikoog using TNRC**

Esther Swankhuisen, C. Smit, C. Both
University of Groningen

Domestic cats are worldwide loved pets for many people, but they are also known to disturb and kill millions of prey species each year. Although the ecological impact of cats is increasingly becoming clear, effective management actions controlling cats are still developing in the Netherlands. One method that is considered to work effectively and has been applied worldwide, is the TNRC method (Trap-Neuter-Relocate-Care). In this talk, I will discuss the effectiveness of the TNRC method for feral cat removal on the island of Schiermonnikoog. With the use of camera-traps, we first estimated a feral cat population of ca. 50 adult individuals and defined so-called 'cat-hotspots'. At these locations, livetraps were placed to capture and remove feral cats from February 2022 onwards. So far, 53 individual feral cats have been captured and removed, including one-third being kittens. However, our camera-trap images still reveal the presence of at least 20 individual cats that need to be captured. Completely removing the feral cat population using the TNRC method is challenging, particularly due to the fast production rates of cats, but also due to free-roaming owned pet cats by people from the village. Hence, a variety of effective conservation management actions are needed to effectively reduce the impact of cats and to protect threatened prey species.

6. Mapping the mammalian predator community and their effect on meadow bird breeding success in an agricultural landscape

Rienk Fokkema, Egbert van der Velde, Marie Stessens, Hesamaddin Farhadi, Daan Bos, Ruth Howison, Taylor Craft, Jos Hooijmeijer, Theunis Piersma
University of Groningen

Meadow breeding birds have always had to deal with predators. Over the past decades however nest and chick losses due to predation have increased, likely due a complex array of factors. However, as especially night-time mammalian predators are elusive, current knowledge on which species are active in the agricultural landscape, their ecology and food- web interactions with meadow birds is still far from complete. Therefore, we placed 60 camera traps in a randomized grid across our 11,500-ha study area in Southwest-Friesland, the Netherlands. We thus obtained a relative index of predator presence in our study area over three study years. Simultaneously, we monitored predation of in particular Black-tailed godwit (L*imosa l. limosa*) nests, to determine the rates of nest predation by the various predator species. I will show the community of different predators we detect, their spatial and temporal variation in presence, explore how it relates to variation in landscape characteristics, as well as relate the actual presence of predators in the environment to observed rates of nest predation. I hope to convince you that knowledge on the complex links between meadow birds and the mammalian predator community is key to assess the impact of targeted meadow bird conservation measures.

3c: Bending the curve: biodiversity-friendly solar parks

Conveners: Thijs Fijen (Wageningen University and Research)
Karen Krijgsveld (Animal Ecology, Wageningen Environmental Research)

In order to produce large amounts of renewable energy many large-scale solar parks are built in agricultural landscapes where the current biodiversity levels are low. If these parks are being managed biodiversity-friendly, they could contribute to halting the biodiversity decline in agricultural landscapes. In this session we will focus on the current below- and above-ground biodiversity values of solar parks, as well as how to improve these in a practical sense.

1. EcoCertified Solar Parks: guidelines and a label for biodiversity-friendly solar parks

Karen Krijgsveld

Wageningen University and Research

Solar parks on agricultural lands provide in the increasing need for fossil-free energy, but many questions remain concerning the value of solar parks for nature. Based on current research and by developing the label EcoCertified Solar Parks, we are enabling the realisation of ground-mounted solar farms that have an added value for biodiversity and soil quality. To build biodiversity-friendly solar parks, clear and unambiguous guidelines are required, for both developers and governments as well as for the general public. With the ongoing research presented in this session, and with previously published results, we are slowly gaining insight in the effects of solar parks on various species groups and the possibilities to increase their natural value. Life at different trophic levels and from different species groups may well have different needs regarding design and vegetation management of solar farms (think of soil life, vegetation, insects, mammals and birds). Here, I present the set-up of the EcoCertified label and discuss the guidelines that are being developed to come to ecologically sound solar park designs.

2. The impact of solar parks on plant biomass and earthworm and nematode communities

Luuk Scholten, Ron de Goede, Gerlinde De Deyn
Wageningen University and Research

Solar parks are a rapidly expanding novel land use primarily to produce renewable energy. However, the aim is to make them multifunctional, and limit negative impacts on soils or even improve soil quality. Solar panels change the microclimate and cause shading below the panels, influencing plant growth and carbon and water inputs to the soil, with potential cascading effects on the soil biota. This research aimed to test the effect of solar panels on earthworm and nematode communities in 12 solar parks with contrasting designs across the Netherlands. Earthworm abundance and diversity, plant biomass and nematode abundance were measured between (gap) and below the solar panels. Nematode abundance was also measured at the highest and lowest edges of the panels. Plant biomass, nematode abundance and earthworm abundance were all significantly lower below the solar panels compared to in the gap between the panels. Nematode abundance at the highest and lowest edges showed intermediate numbers compared to the gap and below the panels. These results show that solar parks have a large impact on the soil biota and stress the need for guidelines for ecologically sound solar park designs to prevent soil damage.

3. Ecosystem impacts of solar farms in temperate agricultural systems

Fabio Carvalho, Hannah Montag, Piran White, Stuart Sharp, Tom Clarkson, Alona Armstrong
Lancaster University

What is the impact of ground-mounted solar farms (SFs) on ecosystem services? Little is understood, though SFs may present risks and opportunities for hosting ecosystems due to their high land take but low infrastructure footprint. In the UK, SFs are commonly built on agricultural land and offer the opportunity to enhance ecosystem service delivery (e.g., soil carbon storage) through land use change by adopting less intensive land management regimes than farming. Through a Knowledge Transfer Partnership with industry, we surveyed 32 SFs in England and Wales in summer 2021 to help elucidate these questions and provide some of the first scientific evidence from the UK. We collected soil and vegetation data from three broad treatment categories: underneath solar panels, between solar arrays and control treatments (e.g., pasture, set-aside land). Results for the different soil and plant indicators varied considerably. Generally, there is evidence SFs can deliver environmental benefits compared to intensive agricultural land, but results show solar panels can have a significant impact on soil and vegetation properties. Our results will help optimise SF design and land management options (especially underneath solar panels) to ensure the long-term delivery of ecosystem services through land use change for low-carbon energy generation.

4. Solar parks – the next best thing in insect conservation?
Timea Kocsis, Arjen de Groot, Thijs Fijen
Wageningen University and Research

Climate change concerns have prompted a global shift to renewable energy, with ground-mounted solar parks expected to significantly contribute to 2050 climate goals. In the Netherlands, agricultural fields are inevitably considered for conversion into ground-mounted solar parks to achieve the set climate targets. This might present unique opportunities for biodiversity improvement in agricultural landscapes due to land-use deintensification. Recent research suggest that solar parks could benefit arthropods and enhance local biodiversity. However, it remains unclear how biodiversity development in ground-mounted PV installations compares to previous land use (e.g. agricultural grasslands), and to nature-inclusive land use (e.g. semi-natural grasslands). In this research we assessed and compared the habitat quality of solar grasslands to grasslands under intensive and extensive use, utilizing plants and arthropods as bioindicators. More specifically, species richness and composition of vegetation was compared between grasslands under different land use intensity, while the arthropod fauna was described with the species richness and functional composition of soil emergent arthropods and airborne pollinators. This research aims to explore the potential of developing multi-functional solar parks that fill in the role of semi-natural habitats and mitigate biodiversity loss in agricultural landscapes.

5. Solar energy on former farmland: co-existing with farmland birds
Sylvia de Vries, Raymond Klaassen
University of Groningen

In the province of Groningen, many solar parks are being realized on arable farmland. This threatens arable farmland ecosystems that are already in decline due to the intensification of agriculture. Farmland biodiversity could possibly benefit from an ecological design and management of solar parks. However, there is a lack of empirical data on the impact of solar parks on farmland biodiversity. As a case study, I studied the relationship between the design and management of solar parks and the abundance and diversity of farmland birds. The first results are based on one year of breeding bird monitoring (BMP) in three large solar parks (44 - 120 ha) and adjacent reference areas. Generally, species preferring more enclosed landscapes containing shrubs and hedgerows, such as Yellowhammer, were more abundant inside solar parks compared to conventional arable farmland, and thus seem to profit from solar parks. In contrast, species inhabiting more open landscapes, such as Skylark, were strongly avoiding solar parks, and thus seem to be threatened by the development of solar energy on arable farmland. We conclude that it is important to acknowledge species-specific effects when evaluating the impact of solar farms.

6. Mammal populations in solar parks, a new land-use type in the agricultural landscape
Chloé Tavernier, Ralph Buij, Rascha Nuijten, Frank van Langevelde
Wageningen University and Research

The biodiversity of the Dutch agricultural landscape collapsed with the intensification of food production. However, in this already fragile environment, lands are now being prospected for renewable energy production. For example, the number of solar parks is increasing dramatically when their impact on the local biodiversity is still unknown. In particular, mammal taxa groups are mostly absent from research on solar parks' impact. Hence, it is unknown, whether solar parks can offer habitat opportunities as foraging grounds, or shelter to species suffering from the agriculture intensification, or whether they harm farmland wildlife. This is why I conducted a monitoring project on 12 (4 – 33 ha) solar parks across the Netherlands. For every solar park, I wished to understand the mammal population composition compared with 2 other land uses, an intensive grassland aimed at dairy production, and an extensive grassland aimed at nature conservation. I conducted a 7-month camera trap monitoring in the 36 plots, capturing a total of 16 wild mammal species. The species did not use the three plots equally, with solar parks and intensive grassland showing a similar profile of species composition. It thus seems that farmland wildlife does not benefit from the presence of solar parks in their environment.

3d: DNA barcodes for biodiversity research

Conveners: Kathryn Stewart (Leiden University)
Kevin Beentjes (Naturalis Biodiversity Center)
Duong Vu (Westerdijk Fungal Biodiversity Institute)

Stemming biodiversity loss requires knowing what species are present, and where, for effective monitoring and management. DNA tools offer a powerful approach that enabls species identification, from focal species or complex communities via blood, tissue, bulk, or environmental samples (eDNA), applied across myriad biodiversity assessments and conservation practices. This session focuses on transformative molecular methods to fill knowledge gaps in biodiversity research, including the development of tools that support these techniques.

1. **Upscaling biodiversity initiatives across the Netherlands: ARISE and e3DNA**
Kevin Beentjes, Kathryn Stewart
Naturalis Biodiversity Center, Leiden University

In the pursuit of stemming biodiversity loss, two ground-breaking initiatives, ARISE (Authoritative and Rapid Identification System for Essential Biodiversity Information) and e3DNA, are poised to revolutionize the landscape of biodiversity monitoring and conservation across the Netherlands. ARISE comprises an unprecedented infrastructure designed to recognize and catalogue all multicellular Dutch species, ensuring that biodiversity information is readily accessible with just a few clicks. ARISE will integrate diverse data sources, ranging from environmental DNA, acoustics, photographs, to observations by citizen scientists. Similarly, the mission-driven e3DNA hub is fostering a widespread environmental DNA (eDNA) community across the Netherlands. With a commitment to sustainability, e3DNA aims to catalyse methodological advancements and collaborative research, creating a bottom-up approach to drive eDNA integration, from education, policy and scientific pursuits. Be it an interest in environmental, ecological or evolutionary (e3) applications of eDNA, the community acts to bolster individual initiatives for broader uptake and advance transformative molecular methods for comprehensive biodiversity assessments and conservation practices. By merging ARISE's comprehensive species recognition infrastructure and e3DNA's community-driven eDNA approach, these initiatives offer an integrated solution to empower effective monitoring and management of biodiversity.

2. **Insulation QuickScan: Cavity wall airborne E-DNA sampling to detect Bats**
Willem van Stein
SGS Global Biosciences Center

Airborne eDNA is relatively new concept that got a lot of attention through publications by Clare et al. and Lynggaard et al. Feb 2022. In the last two years the field has developed fast and expanded into novel applications. At SGS we are progressing rapidly with applying it to cavity walls to determine the presence of bats. Due to a decision by the Dutch Council of State in August 2023 there is an urgent demand for new techniques to determine the presence of bats prior to cavity wall insulation. I will shortly introduce the legislative framework and current solutions, but focus mainly on the initial results of this eDNA technique and how further validation will likely take place. In essence various pilots have been completed utilizing a variety of sampling techniques. Samples have been subjected to meta-barcoding providing a list of bat species, plus also other species that can be used for quality control purposes. A summary of these first results will be presented. In addition, I outline what further field trials are planned to validate both the practical application, as well as the determination of the techniques accuracy.

3. **Extracting quantitative information from eDNA metabarcoding**
Elsa Gerard
Naturalis Biodiversity Center/University of Amsterdam

Describing living community compositions is essential to monitor ecosystems under a rapidly changing world, but it is challenging to produce a fast and accurate depiction of an ecosystem. Metabarcoding is a molecular tool often used to analyse, among others, environmental DNA. It provides relative abundances of genes that may not correctly represent actual living community composition, where only presence/absence data can be safely interpreted. However, it has the potential to deliver fast descriptions of living communities provided that it is interpreted with validated species-specific calibrations and reference databases. We developed an approach to retrieve accurate quantitative information from metabarcoding data by studying foraminifera from coral reefs in Indonesia. We focused on living communities of large benthic foraminifera, calcifying protists, because they are known bioindicators for coral growth and environmental conditions in reefs. Results showed a strong relationship between the number of genes and the size of the specimens. The more (and the bigger) the specimens in the environment, the higher the number of gene copies in the environmental DNA. With proper calibrations, such a quantitative approach bridges the gap between the environment and the data by providing a more complete picture of species composition in the environment.

4. ARISE project and the importance of DNA barcode databases for soil fungal diversity research

Hazal Kandemir, Margarita Hernández-Restrepo, Marcelo Sandoval-Denis, Duong Vu, Johannes Groenewald, Gerard Verkley, Pedro Crous
Westerdijk Fungal Biodiversity Institute

The Dutch project ARISE, which stands for "Authorative and Rapid Identification System for Essential Biodiversity Information" aims to build an infrastructure to identify all multicellular species, including fungi, in the Netherlands. As the Westerdijk Fungal Biodiversity Institute, we are a part of the Sequencing Team of ARISE and responsible for building a database that contains all the culturable fungal species, that were identified in the Netherlands, and their DNA barcode information. To achieve this, we process soil samples to obtain pure fungal cultures to investigate the fungal diversity and identify new fungi in the samples. We extract and amplify DNA from these isolates together with other soil isolates previously deposited in the CBS culture collection. We perform sequencing using the molecular barcodes ITS and LSU and additional markers such as TEF1, RPB1 and RPB2 where necessary for species-level identification. Here, we will discuss our first results pertaining to fungal diversity in Dutch soils and provide more information on how researchers can use the CBS and ARISE databases for fungal diversity research.

5. Modelling ecological barriers to invertebrates in the urban environment with DNA and remote sensing techniques

Joeri Morpurgo
Leiden University

The urban Invertebrate biodiversity faces a non-traditional environment which contains remote and heterogenous patches, known to increases local species extinctions, and decreases opportunities for colonization. Efforts to understand ecological connectedness are often limited to landscape models based on estimates from experts limiting our understanding of species' unique distribution and dispersal experiences. To investigate species distribution, we collected invertebrates DNA through traditional trapping techniques and from the soil (eDNA). Both techniques were separately sequenced and identified to Operational Taxonomic Units (OTUs). The OTUs were used in Species Distribution Models (SDM) predicted by remote sensing data on green and grey spaces. The results show a difference between sampling methods (traditional vs. eDNA). The results from the SDMs, also show clustered communities of co-occurring species and their driving factors. Species distributions were analyzed to estimate the lack of ecological corridors or buffer zones on a species and community-level, and to make recommendations on future green space planning. Importantly, we show that this method of using novel DNA techniques, and combination of modelling techniques allows in-depth assessment of biodiversity and ecological connectivity. These results of ecologically relevant spatially explicit information aid local-decision making in the conservation of species and connecting green spaces in, and around, the urban environment.

6. The impact of flow-induced fragmentation and homogenization on detectable eDNA quantities

Jelle Dercksen, Laura Maria Stancanelli, Krijn Trimbos, Astrid Blom
Delft University of Technology/Leiden University

Prior to being sampled, environmental DNA (eDNA) is exposed to a broad range of environmental variables that may impact the fate and transport capacity of this material, as well as the subsequent inference made by a practitioner based on the genetic signal. In the case of river systems, flow-induced shear effects on eDNA particles remain understudied. In this research, our objective is to shed light on how eDNA quantities are affected by flow. To this end, we have performed a set of eDNA degradation laboratory experiments inside a rotating tank, filled with a mixture of potable water and effluent culturing water of wildtype *Danio rerio* (zebrafish). The degradation experiment was repeated at four different flow rates, for seven days per run. Vertical flow velocity profiles were measured to characterize the hydrodynamic conditions. Our data illustrates that two mechanisms affect detectable eDNA quantities: fragmentation and homogenization of eDNA particles. We attribute fragmentation of eDNA particles to turbulent flow structures. The fragmentation mechanism increased with the flow rate, resulting in an initial increase of detectable eDNA quantities. These results have implications for eDNA sampling strategies in dynamic systems such as rivers and streams.

Parallel Session 4

4a: Unlocking the potential of peatlands: trajectories towards reduced GHG emissions and biodiversity restoration.

Conveners: Matty Berg (Vrije Universiteit Amsterdam)
Gijs van Dijk (B-ware Research Centre)
Bjorn Robroek (Radboud University)
Mariet Hefting (Vrije Universiteit Amsterdam)

After centuries of peatland degradation, peatlands now play an important role climate change mitigation strategies, water retention and biodiversity preservation. In this session we will discuss the impacts of the emission reduction strategies, peatland restoration and conservation efforts on peatland functioning, biogeochemistry and biodiversity. We welcome abstracts on both natural and agricultural used peatland to explore how land management and the restoration of natural processes can help to increase soil carbon storage and peatland biodiversity.

1. **Rewetting without land-use change: Eat your peat and have it too**
Tom Heuts, Quint Van Giersbergen, Reinder Nouta, Tom Nijman, Ralf Aben, Oswin Van der Scheer, P. Heuts, Alfons Smolders, Christiaan Fritz
Radboud University

Agricultural drainage is a primary driver of peatland degradation, causing massive emissions and biodiversity loss, putting an enormous strain on the environment. Water level management (WLM) is a potential solution for peatland restoration, typically involving a land-use shift to paludiculture or nature. This study explored whether an intermediate step is possible, where WLM is implemented without immediately changing the current land use.
We visited fourteen agricultural peatlands in Friesland (the Netherlands), where we measured emissions for two years. Vegetation diversity was assessed in three campaigns, and soil samples were collected. We did not find an emission reduction or diversity increase caused by WLM. The species richness per site, Shannon diversity, and the species richness across all sites were much lower than expected, even for cattle pastures. However, grass harvest and fertilization show a strong correlation with emissions and vegetation diversity.
WLM alone does not effectively mitigate emissions or benefit vegetation without a land-use change, but coupling WLM with a reduction in land-use intensity does correlate with an increase in diversity and a decrease in emissions. Therefore, we conclude that WLM and a reduction in land-use intensity should go hand-in-hand in areas targeted to reduce the degradation of peat soils.

2. **Impact of dry conditions on Sphagnum establishment in bog restoration and paludiculture**
Gabrielle Quadra, Sannimari Käärmelahti, Gijs van Dijk, Greta Gaudig, Matthias Krebs, Anja Prager, Adam Koks, Renske Vroom, Weier Liu, Ralph Temmink, Christian Fritz
Radboud University

Effective bog restoration and Sphagnum paludiculture depend on the successful establishment phase of mosses, a process known to be complex. With intensified drought periods due to climate change, the role of water management becomes increasingly decisive. However, the specific impact of water availability on developing a dense Sphagnum lawn and the nutrient balance across species remains unclear. Such information is crucial for selecting suitable species to ensure successful establishment. Addressing this gap, we conducted a year-long field experiment, monitoring the establishment and nutrient balance of 12 Sphagnum species spread on bare peat subjected to drier and wetter treatments. Mosses exposed to drier conditions exhibited approximately 10% higher nitrogen (N) to potassium (K) and 6% higher N to phosphorus (P) quotients, indicating K and P limitations. Additionally, the drier treatment resulted in an average reduction of 50% in lawn height and 38% in carbon (C) accumulation. Species-specific differences emerged during the experiment, highlighting variations in lawn development and nutrient balance. Common paludiculture species like *S. fallax* and *S. palustre* demonstrated robust performance even under relatively dry conditions, suggesting their reliability in bog restoration and paludiculture.

3. Substrate legacy in peatland restoration

Duygu Tolunay, Joost Keuskamp George Kowalchuk, Gilles Erkens, Peter Veenhuizen, Gizem Ergut, Levi Simon, Mariet Hefting
Utrecht University

Agricultural peatlands in the Netherlands have undergone degradation over the course of centuries, prompting an urgent need for the restoration of ecosystem functioning. This imperative arises not only from climate agreements but also to mitigate socio-economic consequences. This research seeks to examine the effect of substrate legacy in peatland restoration through a field experiment conducted at the Assendelft peat site. One-meter peat cores were sampled and placed in drainage pipes, with half of the samples flipped and repositioned in the field, while the other half remained in the same order of depth as controls. After one year, the oxic-top and anoxic-bottom sections of the cores were harvested to measure concentrations of dissolved organic carbon, soluble iron, and sulphate. Additionally, methane and carbon dioxide productions by microorganisms, along with potential activities of three hydrolytic exoenzymes and phenol oxidase, were assessed. Results indicate that, even after a year, flipped cores exhibited higher CO2 production rates under both oxic and anoxic conditions compared to controls. Elevated microbial activity under anoxic conditions in the flipped cores is supported by lower sulphate concentrations and higher dissolved organic matter concentrations. These findings highlight the importance of considering substrate legacy effects in the planning of peatland restoration.

4. Microbiome legacy influences the global warming potential of peatland soil

Marco Cosme, Willem-Jan Emsens, Inge Van De Putte, Steven Jacobs, Emilie Gios, Hanna Silvennoinen, Ivan Janssens, Ruurd Van Diggelen, Erik Verbruggen
University of Antwerp

Peatlands play a crucial role in climate change mitigation by sequestering substantial amounts of carbon dioxide. However, they can also serve as sources of methane, a potent greenhouse gas (GHG) with aggravated global warming potential. Despite the acknowledged influence of soil nutrients, microbial communities, and vegetation type on GHG emissions in peatlands, our understanding of the relative contribution of these factors remains limited. In this study, we conducted a comprehensive year-round mesocosm experiment, manipulating vegetation type, nitrogen (N) loading, and microbial community in peatland soil. Monthly measurements of GHG emissions were complemented by analyses of vegetation biomass, peat chemistry, and microbiome composition at the experiment's conclusion. Our findings reveal that global warming potential of peatland soil was strongly influenced by both the inoculated microbial community and the vegetation cover. The microbial community composition was primarily shaped by the initial microbiome inoculum, with a secondary impact from vegetation. Surprisingly, year-round N loading exhibited no discernible effects on GHG emissions or microbial community composition. However, it did stimulate or suppress vegetation biomass, depending on either the inoculated microbiome was from a nutrient-rich or -poor peatland origin, respectively. Furthermore, we characterized the functional pathways of bacteria and functional guilds of fungi in the peat microbiomes, and complemented this with annotation-free discovery of microbial functional groups. Overall, our results underscore the significance of the peat microbiome (and its legacy) in shaping the biogeochemical processes that underlie the global warming potential of peatland soil, even under conditions of profoundly changed N levels and vegetation type.

5. Response of soil biota to water level management and nutrient input in fen peat

Annick van der Laan, Nick van Eekeren, Jerry van Dijk, Karin Rebel, Martin Wassen
Utrecht University

In the Netherlands, peatlands are drained for agricultural purposes, resulting in CO_2 emissions, soil subsidence and biodiversity loss. Solutions are found in raising groundwater tables and reducing nutrient inputs. However, knowledge of how these measures affect the soil biota in agricultural peat soils is still limited. Therefore, we conducted a mesocosm experiment in which we exposed 40 fen peat cores (80 cm, 20 cm Ø) to four different water levels (0, 20, 40 and 60 cm below peat surface) and two nutrient application levels. After 14 months, we determined the bacterial, fungal and protozoan biomass. Furthermore we analyzed nematode and earthworm abundance and community composition. Our results show that raising the water level results in a different soil biota composition, with an increase of the microbial part of the food web (bacteria, fungi and protozoa) and a decrease of higher trophic groups (nematodes and earthworms). While water level overall had a stronger influence on soil biota, the effect of nutrient addition became more apparent with increasing water levels. We found that wet conditions in combination with a high nutrient application negatively affected most soil biota groups. Our results will be discussed in the context of ecosystem functioning.

6. From peatlands to seashores: the importance of holistic Wetscapes

Ralph Temmink, Bjorn Robroek, Leon Lamers, Alfons Smolders Tjisse van der Heide
Utrecht University

Peatlands and coastal systems play critical roles in global carbon storage, representing disproportionately small areas but holding substantial organic carbon reserves. The effective sequestration and storage of carbon in these ecosystems, which include peatlands, salt marshes, and seagrass meadows, is attributed to complex feedbacks between geomorphology and vegetation. However, human activities are causing a rapid decline in the extent of these major carbon-storing wetlands, resulting in greenhouse gas emission and biodiversity loss. The urgency of addressing this decline is underscored by the need to preserve and restore these critical functions to align with the goals of international agreements like the Paris Agreement. We argued that creating integrated wetscapes (wet peatland landscapes), including nature preserve cores, buffer zones and paludiculture areas (for wet productive land use), will enable sustainable and complementary land-use functions on the landscape level. Here, we expand the wetscapes concept by building bridges to the coastal realm, because historically, raised bogs and fens were connected to brackish marshes, salt marshes and seagrass meadows. We therefore argue that the creation of 'holistic wetscapes', which includes fresh- and saltwater ecosystems, is key in the conservation of unique biodiversity and restoration of carbon-rich ecosystems in the face of global change.

4b: Countering the Extinction Vortex: Genomic population assessments for Species Conservation Parallel Session

Conveners: Niek Barmentlo (Vrije Universiteit Amsterdam)
Julia Beets (Vrije Universiteit Amsterdam)
Manon de Visser (Leiden University/Naturalis Biodiversity Center)

To preserve fragile species, ecologists are tasked with solving how to effectively assess populations in need of active management. Genomic tools empower researchers to evaluate population dynamics and viability by measuring migratory genetic introgression and assessing (meta-)population genetic health. This session discusses projects linking population genetic structure to species protection. We welcome abstracts discussing local adaptation and genetic health of populations, as well as more applied genetic monitoring projects.

1. **Genomic footprints of urban life in túngara frogs**
Peter Moran, Judith Smit , Andrew Cronin, Paul Jerem, Janine Mariën, Mirte Bosse, Wouter Halfwerk
Vrije Universiteit Amsterdam

Urbanisation is rapidly altering ecosystems, leading to profound biodiversity loss. To mitigate these effects, we need a better understanding of how urbanisation impacts both adaptive and non-adaptive processes. This project investigates the genomic impact of urbanisation on the Neotropical túngara frog (*Engystomops pustulosus*), to better understand how amphibians may evolve in response to rapid environmental change. Túngara frogs are a classic study system for sexual selection and are known to adjust their reproductive traits under urban pressures, making them a valuable system for studying sexual selection in urban environments. While most urban evolution studies concentrate on natural selection, the effects of urbanization on sexual selection remain understudied. Using whole genome resequencing data for multiple urban and forest populations, we examine the genome-wide impact of urbanisation on both adaptive and non-adaptive processes. Combining phenotypic and genomic approaches our study seeks to identify genetic variants that are under selection in urban environments while linking these variants with specific urban-altered phenotypes and environmental factors.

2. **Validating the current Asian elephant subspecies status with whole genome sequences**
Jeroen Kappelhof, Emma Diepeveen, Martijn Derks, Rebekah Rogers, Reeta Sharma, Martien Groenen, Jack Windig, Mirte Bosse
Wageningen University and Research

The Asian elephant (*Elephas maximus*) has been listed as endangered by the IUCN Red List since 1986. Their population size has been declining significantly in the last centuries, mostly due to habitat loss, habitat fragmentation and human-elephant conflict. A broader decline in Asian elephant populations may induce inbreeding depression and a loss of overall genetic diversity, which would affect the population viability even more. At present, there are three subspecies of E. maximus recognized: E. m. indicus on the Asian continental mainland, *E. m. maximus* on Sri Lanka, and *E. m. sumatranus* on Sumatra. A fourth subspecies might exist on the island Borneo (*E. m. borneensis*); they differ both behaviorally and morphologically from elephants of the mainland but are now still subsumed under E. m. indicus. In this study, we obtained samples from 42 first-generation, wild born Asian elephants residing in different European zoos in collaboration with the EAZA Ex Situ Program (EEP). Whole genome sequence data of these samples showed four clusters of individuals from Sumatra, Borneo, Sri Lanka, and the mainland. Bornean and Sumatran elephants seemed more distantly related to the mainland elephants than Sri Lankan elephants. Overall divergence times between the clusters seemed to be quite recent, with a maximum divergence time of 200.000 years. Bornean and, to a lesser amount, Sumatran elephants showed low overall levels of genetic diversity and higher levels of inbreeding. However, all elephants over the entire geographical range, showed similar amounts of nucleotide diversity outside of their runs of homozygosity; indicating a loss of diversity and lack of new unique acquired diversity. In conclusion, this research indicates four distinct clusters of Asian elephants, with quite low divergence times. This divergence of subspecies and signs of lower genetic health in the subspecies of Bornean and Sumatran elephant populations show how genomics could help establish where and how conservation efforts might be required.

3. Plant metagenomics provide evidence of novel honey bee foraging interactions

Sydney Wizenberg, Laura Newburn, Mateus Pepinelli, Ida Conflitti, Rodney Richardson, Shelley Hoover, Robert Currie, Pierre Giovenazzo, Mashaba Moubony, Daniel Borges, Marta Guarna, Ernesto Guzman-Novoa, Leonard Foster, Amro Zayed
York University

Honey bees are efficient pollinators of flowering plants, aiding in the plant reproductive cycle and acting as vehicles for evolutionary processes. Their role as agents of selection and drivers of gene flow is instrumental to the structure of plant populations, but historically, our understanding of their influence has been limited to predominantly insect-dispersed flowering species. Recent metagenetic work has provided evidence that honey bees also forage on pollen from anemophilous species, suggesting that their role as vectors for transmission of plant genetic material is not confined to groups designated as entomophilous, and leading us to ask: could honey bees act as dispersal agents for non-flowering plant taxa? To address this, we first developed a multi-locus pollen metabarcoding protocol and evaluated its utility relative to melissopalynology, using a set of 27 mixed-pollen samples from across Canada. We then applied this approach to explore the scope of non-flowering plant interactions across spatial-temporal gradients using 50 honey bee colonies from southern Ontario. We discovered that honey bees may serve as dispersal agents for an array of sporophytes (Anchistea, Claytosmunda, Dryopteris, Osmunda, Osmundastrum, Equisetum) and bryophytes (Funaria, Orthotrichum, Sphagnum, Ulota). Our findings also suggest that honey bees may occasionally act as vectors for the dispersal of aquatic phototrophs, specifically Coccomyxa and Protosiphon, species of green algae. Our work has shed light on the broad resource-access patterns that guide plant-pollinator interactions and suggests that bees could act as vectors of gene flow, and potentially even agents of selection, across Plantae.

4. Genetic Diversity and Mitogenome Structure of the Dalmatian pelican (*Pelecanus crispus*)

Stijn Kouwenberg, Jeroen Kappelhof, Maarten Vis, Richard Crooijmans, Mirte Bosse
Wageningen University and Research

Modern zoos are crucial for maintaining reserve populations of threatened species. The European Association of Zoos and Aquaria (EAZA) manages these populations through EAZA Ex-situ Programmes (EEPs). Recently, Rotterdam Zoo became the coordinator of the Dalmatian pelican (Pelecanus crispus) EEP and started a long-term research project for this species. This study aimed to provide more insights into the genetic diversity of the captive population and lays the foundation for future genomic research on the Dalmatian pelican. DNA was collected from feather samples of forty Dalmatian pelicans at Rotterdam Zoo. Mitochondrial genotyping was performed to assess the genetic diversity and relationships of the Rotterdam Zoo population. Additionally, a new de novo genome assembly was made using third-generation. This new assembly was compared to two published Dalmatian pelican genomes. Due to difficulties encountered during the genotyping, the mitogenome was also assembled, annotated and analyzed. The twenty-five genotyped Dalmatian pelicans were identical for the mitochondrial ND6 gene. The new assembly had good quality and better statistics than a previous Dalmatian pelican genome assembly. The genomic data indicated low genetic variation, but no recent inbreeding. Furthermore, a duplication in the Dalmatian pelican mitogenome was confirmed, which was absent in previously published mitogenome sequences.

5. Characterisation of deleterious genetic variants in non-model organisms: from present to extinct species

Julia Höglund, Seyan Hu, Martijn Derks, Love Dalén, Mirte Bosse
Stockholm University/ Wageningen University and Research

Species have always been exposed to extinctions. When a population becomes smaller, it becomes prone to inbreeding, genetic variation will be lost, and deleterious variation will increase in frequency. This leads to a worse ability to adapt to changing environments, due to lowered fitness, and could lead to extinction. Hence, there is a crucial need to characterize and quantify damaging variation and its contribution to decline. Such characterisation can be based on predicted deleteriousness. These predictions for deleteriousness are often species specific. Thus, models need to expand accurate prediction beyond model species. Here, we used domesticated pig genomes to develop such a tool to score deleterious variants from sequence data. The short term goal is then to see how generalisable the pipeline, and later scores, are across species. By then comparing the domesticated pig genome to the most recent common ancestor of sister species of different divergence rates, we can gain insight into how the evolutionary scope affects the scoring and thus the prediction of deleteriousness. This will eventually lead to the long-term goal of estimating how much genetic variation contributes to extinction.

6. Nanopore sequencing in molecular ecological monitoring - with a focus on soil nematodes

Robbert van Himbeeck, Sara Giulia Cazzaniga, Sven van den Elsen, Job Oude Vrielink, Semih Karst Aslan, Johnny Visser, Johannes Helder
Wageningen University and Research

Agricultural intensification has resulted in a decline in soil biodiversity, and concerns about the deterioration of the biological condition of soils prompted the development of measures to restore soil life. Due to the overwhelming biodiversity of soils, evaluation of such measures is not straightforward, and proxies are used to assess soil health. Because of their trophic diversity, high abundance, and relatively well-characterized ecologies, nematodes are often used as soil health indicators. However, the scarcity of informative morphological characters hampers the upscaling of this proxy. Here we present a community analysis approach that uses nanopore sequencing to generate full-length sequences of small subunit ribosomal DNAs (SSU rDNA). Cover cropping is a common agricultural practice that stimulates soil life, and we mapped the effects of ten cover crop treatments on nematode communities in a field experiment. These analyses included the monitoring of a high-impact plant-parasite, *Meloidogyne chitwoodi*. In total, 132 nematode samples were analyzed, and 65 nematode taxa were detected, mostly at the species level, including representatives of all trophic groups. As a validation, all samples were analyzed microscopically for *M. chitwoodi*, and a comparison of count and DNA read data revealed highly similar results. Treatments did not only affect plant-parasitic nematodes but also free-living nematodes in a cover crop-specific manner. Free-living nematodes from the same trophic group, and even congeneric species, responded differentially to plant-mediated manipulations of the soil microbiome. Hence, nanopore-based SSU rDNA sequencing could facilitate a substantial refinement of the use of nematodes as indicators for soil health.

4c: Parallel Session 4c: Shedding light on artificial light at night

Conveners: Emily Burdfield (University of Amsterdam)
Kamiel Spoelstra (Netherlands Institute of Ecology)

Artificial light at night (ALAN) has increased significantly over the last few decades and has the potential to disturb a multitude of processes from the cellular up to the ecosystem level. In order to tackle the problems cause by light pollution we need both to understand its effects on different trophic levels and ecosystems as a whole. We also need to test potential mitigation strategies – such as different intensities and spectra of artificial lighting.

1. The attraction of insects to light at night varies with taxon, light colour and time at night

Gabriel Charvalakis, Kamiel Spoelstra, Marcel Visser, Roelof Hut
Netherlands Institute for Ecology

Nocturnal insects are crucial ecosystem service providers and their fitness can be greatly affected by artificial light at night. The attraction of insects to light sources at night (positive phototaxis) can directly impact insect fitness via energy depletion, increased predation risk and by disrupting mating success. Earlier experiments have shown that the degree of phototaxis can vary greatly with taxon, light intensity and colour. However, how the phototaxis of different taxa is temporally distributed over the night remains largely uncharted. A better understanding of how and when light color affects insect behaviour is essential when building tuneable time-scheduled lighting systems to mitigate the impact of light pollution. In this study, we studied the interaction between light colour and time of night on the attraction of different taxa of nocturnal airborne insects using newly developed camera-light-traps with calibrated monochromatic LED lights.

2. Understanding the effects of landscape elements on flying insect biomass in agricultural landscapes using Bayesian modelling

Robin Lexmond
Radboud University

Biodiversity has declined strongly in rural landscapes characterized by intensive agriculture. A way to restore some of the lost biodiversity in these landscapes is the creation of new landscape elements, such as hedgerows and flower strips. However, their effect on insect biomass has not been studied in this context, yet. The evaluation of caught insect biomass is complicated by strong weather effects on insect activity.
Over 3 years we studied flying insect biomass by placing malaise traps at agricultural field edges with or without hedges or flower strips in the Ooijpolder and surrounding areas. We use Bayesian statistical modelling to account for weather effects on caught insect biomass over this period. This approach allows us to quantify the effects of hedgerows and flower strips on flying insect biomass.
Results show that field edges with hedgerows harbor the highest insect biomass, whereas field edges without any natural measure present the lowest amount of caught biomass. This study demonstrates that such landscape elements, evaluated here 15-20 years after their implementation, can be a vital tool for increasing insect abundance in an agricultural landscape.

3. How does light pollution affect predator-prey interactions?

Hannah Broeckx
University of Amsterdam

Artificial Light at Night (ALAN) has surged in recent decades, causing declines in a multitude of taxa and disrupting foodweb interactions. We investigated ALAN's impact on predator-prey interactions in controlled climate chambers, using great tits (*Parus major*) as predators and cabbage moth caterpillars (*Mamestra brassicae*) as prey, placing them on Brussels sprout plants (*Brassica oleracea*). Already under dim light conditions (1.5 lux), great tits exhibited increased nocturnal restlessness and earlier waking compared to dark conditions. Caterpillar behaviors did not differ between these lit and dark conditions: their feeding and hiding behaviors, measured by eaten leaf surface, caterpillar weight, and positioning on plants, were similar. However, caterpillars did respond to the bird predators by hiding more in denser parts of the plants. When testing caterpillar behaviors over 24-hours in three species that differ in their antipredator coloration, we found very distinct behaviors. However, their response to light was uniform with an increase in movement under lit conditions. These findings highlight that light pollution affects species, but that ecological implications are not always straightforward. This emphasizes the need for multi-species and multi-trophic studies to mitigate the negative impacts of ALAN on communities.

4. Colourful Feeding: Altered Bat Feeding Patterns Under Different Light Spectra

Sander Buddendorf
Netherlands Institute of Ecology

Our 24-hour society causes nights to become increasingly illuminated by artificial light at night (ALAN). This can influence the biological clock of organisms, since many evolved together with a 24-hour light-dark cycle. Bats are nocturnal mammals and depend on optimal timing of their activity during the night. The increase of ALAN is affecting bats in many ways, e.g. by decreasing their habitats and disrupting their commuting routes. However, for some common species such as pipistrelle bats, light simultaneously provides opportunities by attracting insects, and thereby potentially expands the time bats can continue foraging during night.
We measured activity of pipistrelle bats near experimental streetlights emitting green, white and red light in natural habitat at eight different locations. We compared the effect of these spectra on nightly foraging patterns and prey capture success. The ability to continue foraging in the presence of light because of continued availability of aggregated insects at predictable locations may benefit this synanthropic bat species on the expense of less common bat species. Understanding how ALAN influences prey-predator interactions through temporal organization is important for effectively mitigating its effects.

5. Urban Digital Twins for Lighting Intervention Planning: The NorDark-DT Case

Ricardo de Silva Torres
Wageningen University and Research

Urban Digital Twins are valuable tools to support better-informed decision-making. Their use has the potential to improve our understanding of urban processes and, therefore, support the development of more sustainable solutions for cities. In this talk, I will introduce NorDark, an interdisciplinary research project that aims to negotiate the needs of humans and wildlife in outdoor lighting solutions implemented in urban green areas. NorDark integrates expertise from light designers, environmental psychologists, wildlife ecologists, physiologists, computer scientists, and sustainability designers to propose light interventions that are not only adequate for humans but also mitigate the impact of light on wildlife. I will also introduce NorDark-DT, an urban digital twin recently developed to support urban lighting infrastructure planning and analysis. I will present the requirements addressed in its design and development, its architecture and components, and illustrate its use in compelling usage scenarios related to the assessment of lighting intervention options in two study areas in Ålesund (Norway) and Uppsala (Sweden).

6. Development of a Biodiversity Planner

Ton de Nijs
National Institute for Public Health and the Environment

Bending the curve of biodiversity loss requires scientific insights in causes of the loss (diagnosis) as well as effective methods to substantiate a societal responses. In this context, a consortium has started to create an operational approach, with "BiodiversityPlanner" as working title. In this project, we want to develop a Biodiversity Planner for use by municipalities, consultancies and others to better include the development and restoration of biodiversity in the development (planning) and management of locations on a local and/or regional scale. The idea is that this planner supports users in nature-inclusive development of areas. It will provide information regarding the various nature and biodiversity objectives in the area, the conditions in the area such as hydrology, land use and management and the opportunities for different species based on species distribution models. The tool will support the development of local objectives by municipalities and suggest specific measures to realize these biodiversity objectives and improve biodiversity in the area. The development of the Biodiversity Planner will be designed in a 'learning by doing' manner based on concrete project areas, in which the desired functionalities of the planner are defined and tested together with the end users in a Living Lab. Recognizing the need for such a Planner, and marking the societal importance of the concept, the Ministry of Agriculture, Nature and Food Safety decided to fund the work. The tool is being developed by a consortium consisting of RIVM, Naturalis, WEnR, Deltares, PBL, SoortenNL, Ravon, Sovon, Vlinderstichting, Floron, Vogelbescherming Nederland, Witteveen en Bos, Vertema Advies en het Deltaplan Biodiversiteitsherstel.

4d: Advancing Biodiversity Monitoring with Satellite and Ground-based Digital Sensors

Conveners: Thomas Groen (University of Twente)
Joris Timmermans (TU Delft)
Geerten Hengeveld (Netherlands Institute of Ecology)
Daniel Kissling (University of Amsterdam)
Chantal Huijbers (Naturalis)

There is a growing interest to develop digital twins of the Earth's ecosystems to enhance our understanding and to contribute to preservation efforts. For the development of such ecosystem digital twins, data from satellite and ground-based digital sensors is critical to constrain the simulations and make high- level fidelity forecasts. Within this session, we explore advances in data-fusion of satellite/ground-based digital sensors with AI for high-resolution biodiversity monitoring. Specifically, we explore 1) the advances to create new ecological satellite products that link remote sensing to biodiversity, 2) the design of automated systems for biodiversity monitoring and the analysis of data with machine learning tools, and 3) the adaptability of underlying algorithms across ecosystems within digital twins. With these insights, we hope to encourage the creation of digital twins for biodiversity and ecosystems and to contribute to solving biodiversity issues.

1. MAMBO at Naturalis: Delving into performances of Machine Learning models for species identification in Computer Vision

Rita Pucci
Naturalis Biodiversity Center

Biodiversity in Europe is currently facing threats from climate change, pollution, invasive species and local private interests of landowners, leading to the extinction of many species. Our contribution to monitoring this issue is the combination of citizen science with automated image classification. This will enable us to better monitor species and their habitats. Machine learning systems have already partially met the demand for biodiversity monitoring, but are not always perfect - do we comprehend the possibilities of such systems? The EU-funded project MAMBO aims to explore innovative and effective solutions to push the boundaries further. We focus on developing new methods to assess observations collected through citizen science. We evaluate the performance of advanced machine learning systems (i.e., convolutional neural networks, and transformers) by assessing their classification accuracy, sensitivity to rare species, ability to identify areas of interest in input images, and interactive features such as response time. We also investigate how different systems classify underrepresented species, how they behave in classifying animals with minimal inter-species variation, and which characteristics of images they consider when providing a classification. By delving deeper into the computer vision research, we can also advance our understanding of the natural world.

2. AI assisted analysis of sticky-traps as monitoring tool for localized insect biodiversity and biomass

Ate Boerema, Rutger Boersma, Arjen Strijkstra
Van Hall Larenstein University of Applied Sciences/University of Groningen

Background: Insects are a diverse and relevant group of animals in the ecosystem. They are fast responders to changes in, management of, the environment and provide important ecosystem services. Localized monitoring of small scale (functional) biodiversity with sticky-traps is easy and cheap and can be very informative.
We developed a method to automatically quantify insects and biomass on yellow and blue sticky-traps. Sticky-traps are digitized using a flat-bed scanner (easily accessible) or in high quality on our sticky-trap-imager. An object detection algorithm (YOLOv7(was trained on >400 annotated traps, resulting in good automatic detection of insects (mAP@0.5=0.96; mAP@0.5:0.95 = 0.7). Subsequently a segmentation algorithm (U-NET) was trained (Dice/F1 value =0.88) to detect body-contours, from which length of insects is calculated and biomass estimated. Insects are annotated the nearest attainable taxonomic unit in our web accessible labeling platform. Based on these labels a classification algorithm is in development.
We have so far quantified thousands of sticky-traps with this method. The method is capable of describing differences in small scale biodiversity in rural, agricultural and urban settings and is sensitive enough to describe differences in small scale insect biodiversity between crops, and in different urban areas. It is a very useful tool that can be deployed by both experts and farmer- or citizen-scientists.

3. Advancing terrestrial biodiversity monitoring with satellite remote sensing

Joris Timmermans, Daniel Kissling
Delft University of Technology

Satellite remote sensing (SRS) provides huge potential for tracking progress towards conservation targets and goals. However SRS products need to be tailored towards the requirements of ecological users and policymakers. To contribute to the goals and targets of the Kunming-Montreal global biodiversity framework (GBF), we propose we suggest two key directions for advancing SRS products and workflows. First, existing SRS-enabled essential biodiversity variables (of above-ground biomass, ecosystem fragmentation, ecosystem structural variance, fraction of vegetation cover, plant area index profile, and land cover) need to be refined. Second, new SRS-enabled EBV data products (e.g. leaf area index, chlorophyll content and flux, foliar N/P/K content, and carbon cycle) need to be developed to better estimate plant functional traits. We identify key-technologies for both these directions and analyze how advancements along these routes greatly improve the progress of monitoring global biodiversity.

4. Investigating the Interplay between Bark Beetle Infestation and Land Surface Temperature as Drivers of Change in Forest Net Primary Productivity

Haidi Abdullah, Elnaz Neinavaz, Margarita Huesca Martinez, Roshanak Darvishzadeh, Mats Lindeskog, Ben Smith, Andrew Skidmore.
University of Twente

The European spruce bark beetle (*Ips typographus*) is considered a highly aggressive insect responsible for instigating outbreaks within European coniferous forests. In recent decades, the escalation of extreme drought events, coupled with heightened temperatures, has led to a notable surge in severe bark beetle infestations. Consequently, these environmental shifts have precipitated substantial alterations in biodiversity within European forest ecosystems. One of the principal catalysts for bark beetle infestation is its profound impact on the ecological evolution of forest landscapes, exerting influence on forest structure and composition. This disrupts the complex carbon cycle dynamics in forest ecosystems. Bark beetle infestation significantly influences the mortality rate of forest stands comprising Norway spruce trees. Such infestations can subsequently engender a decline in the ecosystem's net primary productivity (NPP), which may be considered a health indicator in forest ecosystems. Recent temperature changes attributed to climate change, manifesting as droughts or heatwave events, foster more favourable conditions for bark beetles and exert direct and indirect influences on alterations in NPP. Hence, this study aims to comprehend the complex relationship between NPP, bark beetle infestation and land surface temperature (LST) prior to, during and subsequent to a drought event in Bavarian Forest National Park located in South-eastern Germany. To do so, LST was retrieved applying Earth observation (EO) data (i.e., Landsat-8), particularly emphasising its correlation with bark beetle infestation. In computing NPP, the process-based model LPJ-GUESS was applied, integrating EO data, including leaf area index retrieved from Sentinel-2 imagery with a spatial resolution of 20 meters. Further, the interaction among bark beetle infestation, LST, and changes in NPP was investigated. The findings indicated a gradual decline in NPP over time attributable to bark beetle infestation, a drought event, and a noticeable contrast in LST between infested and healthy stands. The study's results demonstrated lower NPP values in areas affected by bark beetle, particularly after the drought event, compared to unaffected stands.

5. Spatio-temporal species distribution modeling to assess biodiversity change

Babak Naimi, Elham Ebrahimi, Edwin Pos
Utrecht University

Understanding biodiversity patterns and change under climate change is crucial for mitigating the global crisis of biodiversity loss and its conservation. Species distribution models (SDMs) are useful tools for this purpose, but they often neglect temporal variability in species distributions. This study aims to incorporate temporal dimension into SDMs and develop spatio-temporal SDMs to characterize dynamics and trends of change in biodiversity. To do so, we used temporal species data obtained from GBIF as well as time series of climate data obtained from CHELSA. First, we linked species data to corresponding climate variables over time. We then tested two approaches to incorporate temporal data into SDMs. The first approach is based on pooling temporal data into a single dataset and fitting an integrated model, and the second approach uses a moving window over temporal data to fit a separate SDM for each subset of data corresponding to the moving window. We tested different lengths of moving windows including 5, 10, and 20 years to assess the effect of temporal bias. The spatio-temporal SDMs were used to predict the time series of species distributions for each year and then calculated the temporal trend of changes at the pixel level. Our results revealed that increasing the length of the moving window can partially decrease the effect of temporal bias in data and effectively quantify the trend of changes in biodiversity that can inform conservation efforts.

6. Building Digital twins: from data pipeline to ecosystem insights

Geerten Hengeveld, Ioannis Athanasiadis, Elisabeth Bakker, Daniel Kissling, Katja Philippart, Astrid Souren, Karline Soetaert, Zhiming Zhao, Cherine Jantzen, Qing Zhang, Stefan Vriend, Marcel Visser
Netherlands Institute of Ecology

Digital twins are dynamic model-data fusion tools that can help revolutionize ecological research. But how does a digital twin of an ecosystem look like, and how would you build one? The LTER-LIFE infrastructure (www.lter-life.nl) started in 2023 to address these questions and – in doing so –build an infrastructure that allows ecologists to create digital twins for their own research. We illustrate the concept of digital twins, and the infrastructural needs to flexibly assemble them, using two proto-DTs – workflows that have characteristics of full digital twins but are still in their developmental stages. The first proto-DT builds upon the well-established relationship between tree phenology and temperature at the Veluwe, whilst the second provides a near-continuous view on primary production in the Wadden Sea. These proto-DTs illustrate how Digital Twins can be used to gain insights into the functioning of ecosystems. We highlight pros and cons of different approaches, discuss tools currently available and identify the gaps in the infrastructure needed for digital twinning.

Workshop Sessions

1: Your data FAIR and at work, preparing and storing ecological data for re-use

Conveners: Kim Ferguson (Data Archiving and Networked Services)
Cees Hof (Data Archiving and Networked Services)
Stefan Vriend (Netherlands Institute of Ecology)

As a researcher, you create data for your own specific purpose. However, with not too much effort you can increase the FAIRness (Findability, Accessibility, Interoperability, and Reusability) of your data significantly. In this interactive workshop we will show and demonstrate how to choose a proper platform for data publishing, which metadata standards to use, what the preferred formats are for your primary research data, and which services you can use to create the ultimate FAIR datasets.

2: Sharing experiences in working with stakeholders on bending the curve

Conveners: Cassandra van Altena (Netherlands Institute of Ecology)
Sven Teurlincx (Netherlands Institute of Ecology)
Wolf Mooij (Netherlands Institute of Ecology)

One of the most startling aspects of the biodiversity crisis is how much we know and how unable we are to act upon what we know. Collaboration between scientists and stakeholders on social-ecological challenges is thought to lead to actionable knowledge and knowledgeable action. But working with people with diverse expertise and backgrounds is not always easy. In this workshop we want to share experiences on case studies in natural, agricultural and urban areas.

3: Infrastructure needs for experimental aquatic ecology

Conveners: Suzanne McGowan (Netherlands Institute of Ecology)
Koos Biesmeijer (Naturalis)
Tjeerd Bouma (Netehrlands Institute for Sea Research)

What experimental facilities do we need to address the grand challenges for aquatic ecology in the coming decades? Climate change, habitat loss and pollution are contributing to a water quality and biodiversity crisis. As part of the Dutch National Roadmap for large scale infrastructure, we have an opportunity to bid for new national experimental facilities. We invite Netherlands ecologists to come along to this workshop to help develop a consensus on what the discipline needs.

4: Bending the curve of biodiversity decline, for real

Conveners: Rascha Nuijten (Future for Nature Foundation)
Ignas Heitkönig (Wageningen University and Research)

In this workshop we would like to focus on how we can we have a more direct impact on bending the curve of biodiversity decline. Rather than formally presenting papers we would like the participants to communally co-create the added meaning of their research, to provide additional services and to harvest more fulfilment from their science - without losing track of the project goals and timelines. Tools, tips and support from peers contribute to a larger impact.

5: Biodiversity in the political arena: scientists to the rescue

Conveners: Inez Flameling (University College Roosevelt)

Biodiversity and related topics are prominently on the political agenda nowadays. This is good news, but at the same time politicians have a hard time navigating the complex scientific fields and are often bombarded with colored or downright false information from industries and interest groups. Ecologists can help! In this workshop we will discuss the role of science in politics and try out some tools that can help scientists get the message across in political settings.

6: Writing an ecological journal article: a step-by-step approach

Conveners: Rosanna van Hespen (10000words.nl)

A short course on writing an ecological journal article for MSc and PhD students. Touching on all aspects of the writing process: getting started with an outline, tricks to speed up the writing, developing an interesting narrative, how to write clear and concise texts, and more. After finishing the session you will feel more confident about publishing your ecological research.

Poster titles and numbers

Please note that on Tuesday evening 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	Anne Krediet	Earthworm body size and habitat humidity
2	Albert Brangarí	Optimization of microbial traits regulates warming-induced losses in soil carbon stocks
3	Annemiek van Dijke	Disentangling the effects of heat and drought on microbial communities
4	Annemieke Drost	Matter of traits: effects of nutrients and climate change on cyanobacterial bloom toxicity
5	Charel Jager	Natural tree regeneration along a chronosequence of infected Norway spruce stands.
6	Arthur da Cruz Silva	Relationship between vegetation structure, species diversity and aboveground carbon stock in Cerrado
7	Andrea Budiša	HABs in relation to climate change in the North Sea
8	Banchiamlak Getnet Admasu	Review on Pesticide Pollution and Ecological Status of Lake Tana Sub-Basin, Ethiopia
9	Arnaud Louchart	Individual-level trait response of cyanobacteria to environmental variations
10	Bjorn Mols	The impact of rewilding on biodiversity and climate change mitigation and adaptation: a global scoping review of the empirical evidence.
11	Charlie Turlier	Domestic Cat (*Felis catus*) presence and impact around a meadowbird protected area
12	Bogdan Dehelean	Mine traps, a tool for untangling the dynamics of soil life.
13	Carlijn Lammers	Dune grass interactions: sand couch negatively affects establishing marram grass through dune formation
14	Clea van de Ven	The way of the shoot: risk handling by coastal clonal plants
15	Doina Mani	Understanding the Drivers of Belowground Functional Diversity
16	Elise Thijssens & Antonie Kooymans	Artificial reefs in the Dutch Wadden Sea; Biodiversity oases in a soft-bottomed seabed
17	Coline Le Noir de Carlan	Limited role of plants in the composition and structure of soil microbiomes under warming in a subArctic grassland
18	Daniel Varley	Harnessing emergent traits of bivalves in artificial reefs
19	Dajana Radujkovic	The influence of soil community complexity on ecosystem functioning
20	Eva Drukker	BiodiverCity: an ecosystem perspective on the development of biodiverse green roofs
21	Emma Polman	The impact of large herbivore and geese exclusion on vegetation and carbon cycling in the Oostvaardersplassen

22	Femke Keij	Reproducing Reality: A Comparison of Methodologies and Machine Learning Algorithms for the Calibration of Agent-Based Models in Ecology
23	Erne Blondeau	Groundwater level effects on greenhouse gas emissions from peat soil cores
24	Gabriel Rocha	Reducing GHG emissions by steering soil microbiome - ClipsMicro
25	Evy de Nijs	A molecular study on degradation patterns during co-composting of rose waste
26	Giulia Vultaggio	Carbon storage in Dutch agricultural soils (SoilPros)
27	Fanny Spikman	Large grazers in the Drents-Friese Wold.
28	Guusje Koorneef	Project SOLO: Transdisciplinary developing a roadmap of the soil research needs in Europe
29	Fleur Slegers	Forecasting ecological time series using Empirical Dynamic Modelling
30	Harm Bartholomeus	Measuring Vegetation Structure change with LiDAR
31	Gabriel Charvalakis	Attraction of insects to light at night varies with taxon, spectrum and irradiance
32	Hesamaddin Farhadi	The interactions between Godwits and their predators in the landscapes of Southwest-Friesland
33	Gea van der lee	Climate change as emergent stressor for stream invertebrates in the Netherlands
34	Jess Wray	Determinants of Maternity Roost Selection by the Pond Bat
35	Geerten Hengeveld	LTER-LIFE: a research infrastructure to develop digital twins of ecosystems
36	Jiali Cheng	Integrating stakeholders' preferences into model-based redesign for agricultural landscapes to enhance ecosystem services
37	Georgette Lagendijk	Buzzing Ecosystems: Insect abundance along a gradient from conventional to restored grassland management
38	João Salvador Gomes Cruz Pimpão Falé	Trophic Niche of Wintering Short-eared Owls in Portugal
39	Grace Kotnik	Sinking Stars: Experimental Design for Sinking Rates of Chytrid Infected Diatom *Asterionella formosa*
40	Joliese Teunissen	The Role of Plant-Plant Interaction on Bacterial Community Composition
41	Hailley Danielson-Owczynsky	Corophium as an unexpected major prey species of fuelling Bar-tailed Godwits (*Limosa lapponica taymyrensis*)
42	Julia Beets	Understanding genetic variation underlying complex phenotypic variation: impact prediction of genetic variants in Drosophila melanogaster with FlyCADD
43	Heike Markus-Michalczyk	Floodplain forest foundation species Salix alba L. is resilient to seawater pulses: New options for Nature-Based Flooding Defense
44	Jurrian van Irsel	Spatio-temporal Usutu virus distribution and the impact on Common Blackbird populations

45	Isabelle van der Zanden	The role of litter quality and the decomposer community on tree leaf litter decomposition in temperate food forests and grasslands
46	Justine Lejoly	Trophic cascades in soil food webs: consequences for microbial dynamics and carbon cycling
47	Jan Kuiper	The Nature Futures Framework - A flexible tool to support the development of scenarios and models of desirable futures for people, nature and Mother Earth
48	Kaisheng Yao	Ecological Effects of the Insecticide Lambda-cyhalothrin in Sub-tropical Freshwater Mesocosms
49	Kangqing Zhang	Seasonal variation in the gut microbiota of feral pigeons
50	Léon Serre-Fredj	Evaluation of bias and variance in inverted microscope phytoplankton count strategies
51	Keli Li	Environmental DNA (eDNA) approach based soil biodiversity monitoring
52	Lisenka de Vries	Leaving for love: quantifying dispersal between barnacle goose subpopulations
53	Kim Ferguson	Introducing the Data Station Life Sciences: Find, store, and protect your data
54	Jia Peng	Indirect human drivers of diatom diversity in mountain lakes in central China during the Anthropocene
55	Lisa Bruil	Advancing dwarf eelgrass restoration in the Dutch Wadden Sea
56	Joshua Climo	Investigating drivers of the ecological functioning of the Common Meuse
57	Luuk Croijmans	Crop diversification increases conservation biological control: an interactive poster
58	Kimberley van der Meer	First study of home range size comparisons throughout the whole annual cycle of a bird of prey: The Northern Goshawk (*Accipiter gentilis*)
59	Maarten Postuma	Population decline in *A. lyrata* due to climate change investigated using integral projection models
60	Leonardo Bassi	The root collaboration gradient mediates yield decline in 19-year-old monocultures
61	Maite Vogel	Transplant away! First steps in seagrass restoration
62	Luis Felipe Guandalin Zagatto	Soil Biodiversity in Dutch Agricultural Fields and Grasslands (SoilProS)
63	Mandy Velthuis	Responses of lake GHG emissions and carbon storage to eutrophication pressure: a modelling study
64	Marianne Rijtma	Risk analysis to evaluate the environmental suitability for West Nile Virus in Europe
65	Mariana Braz Pires	Greece's endemic flora in peril: conservation priorities amid climate and land-use shifts
66	Mariana Gliesch Silva	Drought effects on plants and soils along a secondary successional gradient
67	Marie-Charlott Petersdorf	Effects of Nitrogen on the reproduction success of *Platynothrus peltifer*
68	Melanie Hagen-Kissling	Collembola in depth: Temporal variability of vertical stratification in the soil profile

69	Michella Ligtelijn	Quantifying flying insect biomass over a land-use intensity gradient in agricultural grasslands
70	Merlijn Schram	Effects of soil inoculation and vegetation diversity on soil functionality in a soil ecotron
71	Michelle Lara	Urbanization Effects on the Reproductive Success of Great Tits (*Parus major*) and Blue Tits (*Cyanistes caeruleus*): A Case Study in Amsterdam and Utrecht
72	Miguel Portillo-Estrada	Opportunities to measure VOCs (volatile organic compounds) real-time emissions with PTR-TOF-MS (proton transfer reaction time-of-flight mass spectrometry)
73	Nacho Villar	Climate-smart rewilding
74	Rosan van Halsema	Citizen Science: ecological water quality monitoring of small waters in the Netherlands
75	Nemi Dorst	Smart urban green infrastructure design
76	Olga Grum-Grzhimaylo	The ability of fungi isolated from oligotrophic peatlands to decompose sphagnum mosses
77	Paul Berghuis	The effect of a future compound drought and heatwave event on the dune building grass *Elytrigia juncea*
78	Paula de la Barra	Warming winters promote biodiversity through reduced mortality of a habitat-forming species
79	Pieter Otte	Small Mustelids in Peril: Investigating Monitoring, Abundance, and Ecology in the Netherlands
80	Reinier de Vries	Farmer profit loss constrains the preservation of grassland biodiversity and public goods
81	Renée Lejeune	Distribution limits of plants and their pollinators in the Scandinavian tundra.
82	Rosemarie Kentie	Do GPS-tags affect gulls?
83	Renée Veenstra	eDNA metabarcoding of faeces reveals new insights in the diet of black-tailed godwits
84	Rick Buesink	Short-term effects of experimental damaging and felling of Scots pine (*Pinus sylvestris*) on saproxylic beetles (Coleoptera)
85	Rong Liu	Coordination of economics spectra in leaf, stem and root within the genus Artemisia along a large environmental gradient in China
86	Pierina Rivas-Comerlati	Effects of the Herbicide Terbuthylazine on Freshwater Communities Under Different Climate Change Warming Scenarios
87	Ruchen Tian	Greenhouse gas and biogeochemical cycles in agricultural soil
88	Sanne Bethe & Julia Marinissen	Litter Decomposition in Dutch Peat Meadows under Different Ditch Border Management Strategies
89	Sam Bielen	The Role of Soil Biodiversity in Forest restoration
90	Shuiqing He	Random Encounter Model for density estimation with vertically oriented camera traps
91	Shunran Hu	Diversified crop rotation systems shift rhizobiomes to facilitate crop growth

92	Simone Weidner	Vulnerability of oxidation – potential respiration and organic matter stability partitioning in soils from managed and natural peatlands
93	Solveig Höfer	Marram Grass - Behind the Scene A tale about Survival, Vitality, Stress & Trade-offs
94	Sina Bohm	Small populations, big challenges: Population vitality in Primula elatior influenced by genetics, demography and landscape
95	Sophia Findeisen	Rocking Heathlands: Exploring Silicate Rock Powder as an Alternative to Liming in the Restoration of Acidified Heathlands.
96	Sophie Planchenault	Microbes unearthed: Linking microbial diversity and carbon use efficiency to carbon storage in soils
97	Sven Meissner	Associations of benthic cyanobacteria with aquatic plants – the influence of biodiversity on exposure to neurotoxins
98	Valentin Heinzelmann	Carbon fluxes under pressure - extreme drought impacts in the sub-arctic
99	Vera van Santvoort	Community-wide micro-evolutionary adaptation to anthropogenic stress: context dependency and ecological implications (COMADAPT)
100	Tamas Fulep	Temporal and spatial distribution of elasmobranchs in Vandalous bay, Sri Lanka
101	Wilco Verberk	ShareTrait: a data portal for making trait data interoperable and reusable
102	Wouter van der Vegt	Stairway to urban Heaven? Abundance and species richness of Carabidae along two urban-rural transects
103	Xiangyu Liu	Distance- and density-dependent recruitment of tansy ragwort is not driven by plant-soil feedbacks
104	Wiene Bakker	Effects of different mowing treatments on biodiversity and ecosystem services in road verges
105	Yuxin Wang	Species-specific differential impact of protists in controlling microbial-mediated litter decomposition and plant growth
106	Sterre Witte	Providing habitat for subtidal shellfish reefs
107	Misty Hu	Utilizing Camera Traps to Evaluate Natural Enemy Effectiveness and Movement Patterns in Strip Cropping for Insects
108	Savannah Sarkis	Combined effects of CO2 and nitrogen on the ecophysiology of the toxic cyanobacterium Microcystis aeruginosa

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 who 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 who 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: **slido.com**, and use pin code **#NAEM24** 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. 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

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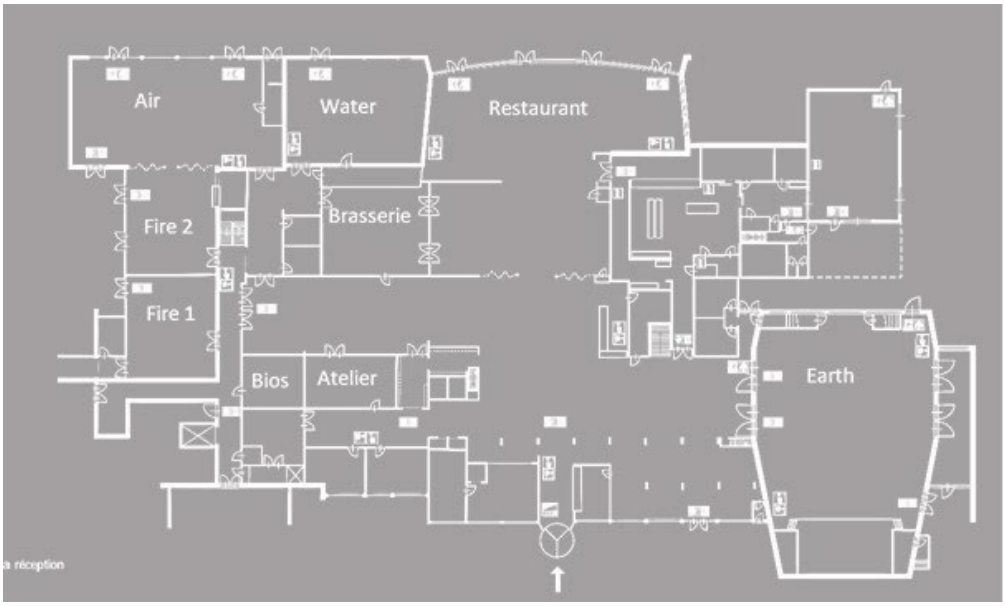
NOTES

Practical information

Checking in to your rooms is possible from 15hrs. Please ask at the reception for help if you need to leave your bags.

Map of the conference area

Ground floor



1st floor