Mast-EER Project Booklet

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Introduction

This document provides you with an overview of some of the possibilities for research projects/themes/supervisors when you join the Mast-EER MbyRes cohort. Whereas some projects are worked out in some detail, others outline possible directions that you could pursue.

In all cases, these projects should be considered the starting point of your journey as a MbyRes student. Indeed, you will spend the first months of your project to develop your project, working closely with your supervisory team and with input from ARIA, ensuring it is aligned with the EER opportunity space.

In addition to the people and projects listed here, we encourage you to do your own research and explore the CEC's large and diverse list of researchers, as well as potential co-supervisors in other departments and institutions.

We strongly encourage you to reach out to potential supervisors before applying. They will be delighted to hear from you!

General questions?

Dr MD Sharma: M.D.Sharma@exeter.ac.uk

Dr Erik Postma: E.Postma@exeter.ac.uk

Overview of possible supervisors

Prof. Dave Hodgson

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I work on the use of resilience theory to understand (a) population and community responses to environmental disturbances and perturbations, and (b) the evolution of life histories in the face of demographic disturbances. I've published on resilience theory, and on life history evolution. I work with Robust Control mathematicians on the use of Pseudospectrum maths to help predict ecological stability and resilience.

Life history resilience in the face of demographic insults

Murray et al (2026; American Naturalist) describe how demographic disturbances favour the emergence of the slow-fast continuum of life histories. Disturbances cause selection for life histories that either resist disturbance or recover quickly, and the negative association between resistance and recovery favours life histories aligned along the slow-fast continuum. Given this theoretical basis, the project will use databases of real-world life histories, and the demographic disturbances they face, to understand how selection for resilience plays out in nature.

Pseudoresilience of ecological assemblages

Our proposal is to develop the use of Pseudospectrum theory & tools to measure and understand the stability of ecological communities. The pseudospectrum recognises that classical eigenvalue-based measures of stability do not account for variation or uncertainty in measures of interaction strength. If we are to design resilient ecosystems of the future, we must improve how we predict ecosystem stability. The project will involve a mixture of pseudospectrum tool-development, a review of stability of ecological assemblages, and an application of pseudospectrum tools to help judge the pseudostability of real-world ecosystems.

Prof. David Hosken

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I am interested in experimental evolution as a tool to enhance ecosystems resilience.

Possible projects

There are a number of projects that can fit within the above framework. These range from the benefits of sexual selection to resilience, to adaptation to temperature elevation, and the foci can be physiological, evolutionary or some combination of the two.

Prof. Tom Tregenza

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I believe that a potential large-scale insect rewilding experiment does offer the potential to drive a step change in rewilding practice which is currently dogged by objections based on fears of maladaptation.

An experimental approach to reestablishing a native insect to the UK

Rewilding normally involves introducing animals from wherever they are sufficiently abundant to tolerate collection, raising concerns about local adaptation (or lack thereof) to the reintroduction site. Sometimes there are options to try to match the source environment to the proposed reintroduction site, but this always comes with additional costs in terms of time and effort. Furthermore, we have very little idea about how important local adaptation is to the success of reintroduction attempts. This project would aim to identify a number of potential reintroduction sites for the field cricket *Gryllus campestris* in the UK. This would create the potential for an experiment in which crickets from divergent habitats in Spain are introduced to UK locations and their success or failure monitored. A range of experimental designs are possible, and choosing amongst them would be an important aspect of the project.

Dr Mark Hanson

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My ARIA-aligned research projects investigate how diversity in immune genes can promote a more robust potential for adaptation to rapid ecological changes. Microbes in the environment are strongly determined by seasonal and climatological effects, and climate change is likely to transform the UK climate into one that looks more like Spain by ~2041-60. To ensure UK species are able to adapt to the new microbes, parasites, and pathogens that will accompany this change, migrating northward from their current geographical ranges, we will investigate key genetic variation in antimicrobial peptides, immune genes critical for defence against ecological microbes. We will focus on UK insect species, with an effort to adapt protocols for transgenic injections that will facilitate our study of these immune parameters, and provide training to students for future scalability in producing transgenic insects that could boost future conservation efforts.

AMPed: determining the ecological drivers of variation in critical antimicrobial peptide genes

The innate immune response is a critical front-line defence against infection. With ongoing climate change, pathogenic microbes will migrate northward that UK populations are poorly adapted to deal with. Recent work in insects and other animals has revealed that genetic variation in antimicrobial peptide (AMP) genes has immense consequences on defence against infection by ecologically-relevant pathogens. The importance of single AMP genes in these infections has been surprising, and we are now characterising the boundaries of this novel host-pathogen interaction paradigm. This project will build genetic tools in a British/European woodland fly to understand how its Diptericin AMPs have evolved to control ecologically-relevant taxa to their geographies. Understanding the importance and principles of these interactions will equip us to better understand the pathogenic threats of the near future. This understanding will help us to equip UK species for future infectious threats.

Equipping Red mason bees for the infection pressures of a changing climate

Red mason bees are ecologically & economically important pollinators in the UK. These bees are commercially-reared for apple & winter rape pollination, and wild bees pollinate many UK plant species. The microbiome is an important determinant of insect health. Work in insects finds that naturally-occurring variation in antimicrobial peptides (AMPs) greatly determines defence against infection by key microbiome members. Climate change & habitat disruption are changing the microbial ecology landscape of the UK. By 2060, the British climate is projected to mimic that of Spain. AMP allele frequencies vary by latitude, suggesting certain alleles combat climate-specific threats. We will investigate AMP variation in Osmia & other bees. Next, we will use peptides *in vitro* and fruit fly model genetics *in vivo* to test the function of AMP polymorphisms against key microbes. We will learn drivers of AMP variation, ensuring immune genetic diversity in commercial bees is equipped for future threats.

Dr Jolyon Troscianko

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I work on the impact of light pollution on animal behaviour and ecological interactions, with a focus on the impact on biodiversity and ecosystem functions (pollination, predator-prey dynamics). I have also developed novel AI (deep convolutional neural net) techniques for real-time tracking and quantification of animal behaviour from video using low-end hardware.

AI-powered street-lights that actively balance ecological harm and human safety

We will develop AI-enabled streetlights capable of real-time monitoring of humans (vehicles, cyclists, pedestrians) and nocturnal animals (moths, flies, bats, birds). These lights will be able to actively adjust their intensity and spectrum to trade off human safety with ecological harm. We already have a prototype on campus, and have secured control of the lighting in car park J to use as a lighting technology test-bed, making our campus a world-leading site for experimental development of novel lighting solutions. This masters project would focus on model training and testing, quantifying light responses in key animal assemblages, and developing scalable data flow systems. Large networks of AI-street-lights would be able to collect vast, tractable datasets invaluable for road safety planning and policy, reducing light pollution, reducing electricity consumption, and providing real-time detailed data on the activity and movement patterns of ecologically critical nocturnal animals.

Dr Sarah Nelms

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I am interested in understanding the impact of anthropogenic activities on marine megafauna and how they affect species resilience to inform evidence-based policies. I am furthermore interested in how AI-generated images affect people's perceptions of wildlife and environmental issues, and how this feeds into decision-making and lobbying

Sentinels of the sea: Using humpback whales as a barometer of ocean health

The ocean is changing faster than at any point in human history, with marine biodiversity at the frontline of global environmental disruption. Climate change and other anthropogenic pressures are altering habitats, species distributions, and ecosystem processes across the northeast Atlantic. A notable trend is the increasing occurrence of humpback whales in UK waters, where they were largely absent 40 years ago. While often viewed as a conservation success, the drivers remain unknown. This increase may reflect population recovery following the cessation of whaling, yet limited knowledge of historic distributions and contradictory evidence challenge this explanation. Alternatively, as marine mammals are bioindicators of ecosystem health, changes in humpback distribution may signal broader environmental change. This project will determine whether we are witnessing ecological restoration or environmental disruption, informing our understanding of marine ecosystem resilience.

Assessing the impacts of generative AI and/or the attention economy on Biodiversity

The project will look at the use of generative AI and its impacts on biodiversity e.g. human-wildlife interactions, illegal pet trade, misinformation/perceptions, influence on decision-making (e.g. policies and lobbying)

Dr Barbara Tschirren

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My research aligns closely with ARIA's EER mission to engineer ecosystem resilience, especially in the context of wildlife-driven zoonotic disease risks. I develop innovative, data-driven approaches, combining genomics and field technologies, to predict and reduce transmission hazards while minimising ecological disruption. This work advances targeted interventions that curb disease emergence while actively supporting biodiversity recovery.

Precision Genomics for Targeted Control of Bovine Tuberculosis in European Badgers

Bovine tuberculosis (bTB) remains a major economic and ecological challenge in the UK, with European badgers acting as key wildlife reservoirs. Current control strategies - culling and vaccination – are indiscriminate tools, raising ethical, societal, and conservation concerns. This project integrates genomic prediction with long-term badger population datasets and ongoing intervention trials to identify individuals with disproportionate onward transmission risk ('superspreaders'). We will develop a rapid, field-deployable genotyping tool, enabling real-time risk stratification and targeted intervention. By shifting from population-level to individual-level management, this project aims to dramatically increase the effectiveness, acceptability, and sustainability of bTB control. The approach will deliver a step-change in wildlife disease management, reducing unnecessary culling, supporting biodiversity, and safeguarding the livestock industry.

Dr Ramakrishnan Vasudeva

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One of my interests in evolutionary ecology is how thermal biological rules shape life histories. To this end, I have access to a unique biological resource (six replicate beetle populations evolving at thermally divergent regimes). Both males and females evolve within these environments and some aspects of their life histories have evolved (e.g., development, size). There is data to support that male reproductive behaviour has shifted with warmer males performing well under simulated heatwaves. A key question that remains answering is how survival of the sexes is shaped by thermally evolving in divergent regimes (30°C versus 38°C, six replicates each).

Surviving heatwaves: an experimental test using thermally evolving beetles

There is evidence for dimorphism in traits shaped by natural- and sexual-selection. However, how climate change interferes with this is limited. Populations experiencing catastrophic climate change must survive and successfully reproduce. Here, using long-term thermally divergent lines to explore how simulated heatwaves impact ale, female and life stage survival. Essentially, this dataset will produce a comprehensive data that models thermal death time using an established biological system. The species lives long enough (~ 52 weeks) under controlled conditions to provide meaningful long-term data taking into account thermal histories and whether heatwaves interact with a dimorphic trait.

Dr Ben Longdon

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My research focuses on how pathogens emerge, spread, and our ability to predict and ultimately control emergence in natural ecosystems. I study the ecological and evolutionary drivers of virus host shifts – where pathogens jump between species – that are a major source of emerging infectious diseases. My group uses tractable insect–virus systems to experimentally test how host relatedness and host–parasite evolutionary history shape infection outcomes. We are also quantifying how ecological and evolutionary process's structure viromes in natural insect communities, supporting ARIA EER priorities in prediction and intervention. By combining experimental evolution, comparative infection assays, and genomics, my work identifies general rules governing pathogen spread and host susceptibility, contributing to efforts to measure, predict, and ultimately engineer ecosystem resilience in the face of emerging biological threats.

Predicting and engineering community resistance to pathogen emergence

Virus host shifts - where a virus jumps between host species - are a major source of emerging infectious diseases (e.g. HIV, Ebola, SARS-CoV-2), yet we lack the frameworks to predict and prevent them. This project will harness host community composition as a programmable architecture to predict, and engineer resistance to viral emergence, establishing scalable resilience to biodiversity loss. We will optimise communities by precisely tuning phylogenetic relatedness, species susceptibility, and diversity to identify the leverage points that suppress transmission. Crucially, we will determine how targeted micro-interventions, e.g. altering a single species/trait, can dramatically suppress outbreak risk and constrain virus evolvability. Using AI modelling of contact networks, we will validate these interventions in lab systems and extend them to semi-natural ecosystems. This will allow us to identify generalisable design rules and constraints for scaling ecosystem resilience.

Dr Alex Hayward

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In my research I aim to gain a better understanding of how the genome facilitates evolutionary novelty to fuel adaptation.

Understanding the role of transposons as drivers of adaptation

The project uses the duckweed system to explore how stress impacts on transposon activity. This can consider wild populations from stressful environments, as well as directly applying stress in the lab to test for evidence of transposon mobilisation.

Dr Karl Wotton

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My research explores how mobile species (migratory pollinators) contribute to ecosystem resilience by linking fragmented habitats and stabilising ecological networks. Migratory pollinators act as natural agents of connectivity, redistributing biological material and interactions across landscapes. This aligns with ARIA's Engineering Ecosystem Resilience (EER) space by framing ecosystems as dynamic systems whose functionality depends on connectivity, redundancy, and adaptive reconfiguration. By quantifying how ecological networks respond to disturbance and the influx of mobile organisms, this work generates insights into how resilience can be understood, predicted, and potentially enhanced. It provides a biologically grounded framework for designing or managing ecosystems that maintain function under environmental change.

Migratory pollinators as natural engineers of ecosystem resilience

This project will investigate how mobile organisms reshape ecological networks using an integrative, technology-driven approach. Field sampling will be combined with DNA metabarcoding to characterise species interactions, while AI-assisted detection methods will enhance identification and quantification of migration. Movement patterns will be analysed using predictive modelling, including trajectory simulation and atmospheric data, to infer drivers of movement and connectivity. Network analyses will quantify changes in structure, robustness, and interaction diversity over time. The project will assess whether migrants introduce novel interactions and increase resilience to species loss. Results will provide a tractable UK-based test of how mobile species act as "connectivity agents", with implications for designing habitat networks that enhance ecosystem resilience under environmental change.

Prof. Alex Mesoudi

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My research focuses on human social behaviour and how cultural knowledge spreads, accumulates and evolves through human societies. Given that ecosystem resilience is crucially dependent on the human actions that typically modify and disrupt such ecosystems, a better understanding of how human practices vary, change and evolve will be crucial for engineering more resilient ecosystems. My previous research most relevant to these issues has examined how human social learning biases facilitate or hinder the spread of adaptive knowledge (Derex et al. 2024, PNAS), how cultural adaptive dynamics relate to multilevel social-ecological processes occurring at different scales (Reyes-Garcia et al. 2014, Ecology & Society) and how dynamic human social network structures affect the spread and accumulation of cultural information (Derex & Mesoudi 2020, Trends in Cognitive Sciences).

Dynamic Bayesian Simulation Models of Social-Ecological Networks

It is increasingly recognised that ecosystem resilience requires an understanding of human social networks and social behaviour, given that human interference is a major source of ecosystem instability. This project will significantly advance the study of social-ecological networks, which formally describe interdependencies between human nodes (e.g. fishers, farmers, NGOs) and ecological nodes (e.g. species, populations, habitat patches). Addressing a paucity of formal modelling of social-ecological networks, this project will use recently-developed dynamic, multilevel, Bayesian network models (e.g. via R packages STRAND, Stbayes) to simulate different forms of social-ecological network interdependencies (e.g. collaboration, competition, resource extraction) at multiple levels (e.g. individuals/patches to institutions/species/communities) to help guide interpretation of causal effects in the empirical literature and generate novel network interventions to improve ecosystem resilience.

Dr Elze Hesse

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My research interests lie in the combined use of microbes/plants to accelerate restoration of mine-degraded environments, using high-resolution measurements with targeted interventions to prevent ecological collapse

Driving the Rhizosphere: Plasmid Dynamics for Rapid Soil Restoration

Industrial soil pollution outpaces natural plant adaptation, but root microbiomes offer rapid evolutionary responses. This project investigates how rhizobacteria help plants adapt to toxic metals, focusing on transmissible plasmids. These elements will be engineered to carry genes for extracellular siderophores—chelators that mobilize iron and detoxify metals. Crucially, hyperaccumulating plants often take up metals better when bound to siderophores. Because siderophores function extracellularly, they represent a public good vulnerable to exploitation by non-producing cheats, which can destabilise communities. We hypothesize that plasmid transfer acts as an ecological gene drive, rapidly spreading tolerance traits through rhizosphere populations to maintain cooperation. By combining synthetic communities and experimental evolution, we will determine if plasmid dynamics can sustain public goods, and ultimately accelerate plant adaptation and ecosystem restoration of contaminated soils.

Prof Jeremy Field

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I have a long-term interest in the behaviour and ecology of bees and wasps including work on how climate change is expected to influence foraging and pollinator resilience.

Group size and pollinator resilience

Bees and wasps are the major pollinators of both wild plants and the crops that humans depend on. Just in the UK there are over 500 species with widely varying ecologies, and it is unclear which should be prioritized when making management decisions. The focus has so far been on honeybees and bumblebees, neglecting the vast majority of taxa. This project would investigate whether social group size could be the basis for decision-making through its influence on pollinator resilience and therefore food security. For example, are larger groups better able to reduce the variance in food returns to their nests, as theory would predict, and does this enhance reproductive success? Can smaller groups or solitary bees compensate for this behaviourally, for example by prolonging foraging after they have been less successful? The work would include manipulating group sizes and using AI-based software to monitor foraging and reproduction.

Lucy Woodall

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I work in the transdisciplinary space to support sustainable marine management and conservation with research directly impacting contemporary ocean challenges and support international targets and goals such as SDG14.

Supporting coral regeneration with 3D printing artificial reef substrates

Coral reefs are declining globally due to climate change and pollution. While conserving natural reefs is the most effective way to maintain biodiversity and ecosystem services, restoration methods can help support recovery where degradation has already occurred. Current restoration approaches are often costly and ineffective. A promising alternative is the use of 3D-printed artificial reef substrates. The central research question is how we design to encourage natural coral recruitment and lower the energetic costs of attachment while maintaining structural stability. This project will develop and test novel substrate material and shapes through controlled laboratory and trials. Mechanical testing and attachment studies will provide data on how substrate properties influence ecological processes. The findings will guide future substrate designs and generate policy-ready insights on how artificial reef technologies can support restoration at scale.

Prof. Chris Bass

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For an overview of how my research is aligned with ARIA's EER opportunity space, see outline below.

Harnessing Nature's Blow Torch to Protect Bees

As insects, bees are potentially vulnerable to insecticides, thus understanding the factors influencing bee sensitivity to these chemicals is essential to safeguard their health and the ecosystem services they provide. We recently demonstrated that bees are equipped with specific detoxification enzymes called cytochrome P450s that act like nature's blowtorch, cutting through insecticidal compounds and rendering them toxicologically inert. Intriguingly, recent research has shown that the expression of these P450s can be strongly influenced by diet and the microbial community within the bee gut, and this has been correlated with increased tolerance to pesticides. Collectively, these findings offer an exciting prospect – can we enhance bee resilience to pesticides by supercharging their natural xenobiotic defence systems (turning up nature's blowtorch)? Our project will identify and exploit conditions that promote the expression of detox genes and enhance pesticide tolerance in bees.

Dr Dirk Sanders

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My research interests focus on understanding how ecological communities maintain stability and function under environmental change. In particular, I am interested in the mechanisms that underpin ecosystem resilience, including functional redundancy, ecosystem-engineering traits, and the relationship between biodiversity and ecosystem functioning. The proposed research aligns strongly with the Engineering Ecosystem Resilience opportunity space by investigating how resilience emerges from the structure and composition of ecological networks. Using experimentally tractable microbial communities, the project will explore whether key functional traits can sustain ecosystem function despite species turnover and environmental perturbation. This directly addresses EER priorities around identifying the traits, mechanisms and network properties that enable ecosystems to persist under change.

Species Turnover and Functional Stability in Soil Microbial Communities

Human activities are accelerating rates of species turnover across ecosystems, raising concerns about the persistence of ecosystem functions that underpin stability. A major challenge in resilience science is identifying the traits and mechanisms that enable ecosystems to remain functional despite changes in species composition. This project will investigate whether functional redundancy enhances ecosystem resilience by buffering ecosystem functions against species turnover. Using characterized soil bacterial isolates, this project will use experimental microbial communities to vary in levels of trait diversity, functional redundancy and species turnover, with particular emphasis on siderophore production as an ecosystem-engineering trait. Controlled species replacement treatments will be used to test whether ecosystem functions can be maintained despite community changes, while heavy metal exposure will provide an environmental perturbation to challenge community resilience.

Prof. Alastair Wilson

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Assisted migration—human guided translocation to more suitable habitats—is a widely proposed form of ecosystem engineering in marine systems. This project develops the snakelocks anemone (Anemonia viridis) as a model to evaluate the risks and benefits of assisting range shifts in sessile species threatened by climate change. This parallels tropical marine models (aiptasia, corals) but with a focus on cold-water ecosystems. Despite a broad latitudinal range, Mediterranean Anemonia populations are declining as thermal stress disrupts photosymbiosis, while UK populations are now range shifting north. As both autotroph and active predator/competitor, with rapid clonal growth, Anemonia can also become invasive outside its native range. Its tractability in the field and the lab enables integration of ecological and behavioural studies with genomic, proteomic and cell-biological data to uncover – and manipulate - mechanisms of thermal tolerance, symbiotic (dis)function and invasiveness.

Assisting adaptation in cold-water marine systems

This project will use the snakelocks anemone (*Anemonia viridis*) as a model to evaluate the risks and benefits of assisting range shifts in sessile species challenged by climate change. It will test for natural adaptation of thermal tolerance in anemones from across a latitudinal gradient (Spain->Scotland), mapping these against population genetic structure (including possible cryptic species). Using wild collected animals, a student will also develop a panel of clonal lines under controlled conditions, allowing us to characterise, and ultimately manipulate, genetic (co)variation in traits and mechanistic pathways linked to symbiotic performance (e.g. symbiont rejection, markers of oxidative stress) and stability, growth and reproduction, and aggression and competitive ability (linked to invasiveness risk). Specific goals will be co-developed with a student and in collaboration with co-supervisor Prof Ross Waller (Biochemistry, University of Cambridge).

Prof. Camille Bonneaud

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My research focuses on emerging infectious diseases at the wildlife-livestock interface, integrating ecology, evolution, epidemiology and environmental management to understand how pathogens emerge, spread and persist in changing landscapes. Host-pathogen coevolution and the evolution of pathogen virulence are key areas of my research, including how ecological and environmental conditions shape disease dynamics and pathogen adaptation. I am particularly interested in how habitat restoration, biodiversity recovery and agricultural management can be designed to enhance ecosystem resilience while minimising disease transmission among wildlife, livestock and people. I am also interested in developing approaches for detecting emerging disease threats, including the use of AI and community-based surveillance that empowers farmers and local communities and improves preparedness for future biological threats.

Designing landscapes resilient to disease risks at the domestic-wildlife interface

As investment in nature recovery increases, there is an urgent need to understand how habitats, species communities and landscape connectivity influence disease risk at the wildlife-livestock interface. This project will investigate how habitats on and around farms shape contacts between wildlife and livestock, and whether landscapes can be designed to support biodiversity recovery and disease resilience. Using ecological surveys, wildlife monitoring and farmer engagement, the project will quantify wildlife use of farmed landscapes, identify habitats associated with high- and low-risk contacts, and explore how landscape design influences pathogen transmission. The project will also draw on farmers' knowledge of wildlife-livestock interactions and assess their willingness to adopt habitat management strategies that reduce disease risk. The findings will identify nature-based solutions that protect productivity, reduce outbreak losses and support participation in land management schemes.

Prof. Andrew Young

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My group focus on social evolution and senescence and their impacts on the resilience of animal populations under global change. Our work on cooperative birds investigates why such species are globally associated with unpredictable rainfall regimes, the resilience mechanisms they have evolved to thrive in such conditions, and the extent to which these will protect them under anthropogenic global change. Our work on European badgers investigates resilience across the life-course; in particular how senescence reflects a late life decline in resilience. Our strongest contribution to the EER Opportunity Space may therefore be made through the use of these model systems to develop and illustrate (i) novel generalisable statistical tools to characterise organismal resilience to complex time-lagged and spatially variable environment stressors such as low rainfall, and (ii) pipelines for testing how such resilience performs under predicted future climate scenarios.

Climate resilience in European badgers: developing novel tools for assessing resilience to complex time-lagged hazards

Attempts to understand and engineer ecosystem resilience are hampered by shortcomings in the methods currently used for characterising organismal resilience to environmental change. This is particularly true for variables such as rainfall, that have complex lagged effects on biological processes stemming from their integrated values over unknown time frames. To address this challenge, we will build upon recent advances in global change healthcare to develop new statistical methods for characterising resilience in ecology, and will assess the utility of these methods by studying climatic resilience in European badgers. The project will be delivered as a collaboration between ecologists (Ecology & Conservation), statisticians (Mathematics & Statistics) and the Animal & Plant Health Agency, who lead the long-term UK badger study. The project will offer exceptional skills training in resilience science and advance the state of the art toolbox available for quantifying ecosystem resilience.

Landscapes of resilience in birds: developing novel tools for identifying spatial drivers of resilience to environmental change

Many organisms are thought to achieve resilience by spatially associating with microhabitats that reduce their exposure to environmental change. However, our ability to identify such microhabitats (and leverage them when engineering resilience), is constrained by our toolkit for the spatially explicit analysis of landscapes of resilience. To address this challenge, we will build upon recent advances in global change healthcare to develop new methods for the spatial analysis of variation in resilience to environmental change, and assess the utility of these methods by studying the microhabitats that convey climatic resilience in birds. The project will be delivered as a collaboration between ecologists (Ecology & Conservation), statisticians (Mathematics & Statistics) and remote sensing experts (Geography). The project will offer exceptional skills training in resilience science and advance the state of the art toolbox for studying spatial variation in resilience.

Dr Aimee Murray

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Living organisms underpin our food, climate stability, and materials – ecological collapse threatens the foundations of civilisation". Microorganisms are the most abundant life form on earth, and underpin fundamental ecological processes. For example, bacteria are critical for the nitrogen cycle, soil health, and symbioses. However, they can also cause problems, such as antimicrobial resistance, which impact health, food and waste systems. I work on antimicrobial resistance in bacteria, particularly how this evolves in complex microbial communities relevant to different contexts (human health, fresh water, waste management, food systems). I specialise in how exceedance of the 'novel entities' boundary could be exacerbating antimicrobial resistance through bacterial exposure to environmental pollutants, including antimicrobials, pharmaceuticals, chemicals and microplastics.

Assessing the combined impact of wastewater contaminants on antimicrobial resistance

Wastewater contains bacteria, as well as chemical and physical pollutants (e.g., antibiotics, pharmaceuticals, chemicals and microplastics). Despite wastewater treatment, these can still enter the environment (and are sometimes directly discharged, e.g., through combined sewer overflows, permitted releases, reuse of sewage sludge as fertiliser, or in countries with inadequate management/treatment infrastructure). There is evidence that in isolation, many of these different pollutants can select for antimicrobial resistance, but many have not been tested at all and the potential synergistic effects of these compounds have not been explored. This project, informed by ongoing research programme, would address these gaps. Findings would be used to conduct environmental risk assessments to aid mitigation efforts to protect our environment.

Microplastics as drivers of antimicrobial resistance

Microplastics are present in wastewater, where they may even be used as part of the treatment process. However, emerging evidence indicates that microplastics may preferentially support the growth of antimicrobial resistant bacteria. This may result in pathogens being sheltered from the biotic and abiotic factors that may otherwise result in their extinction, enabling them to survive transitions between environments beyond their typical ecological niches, whilst simultaneously widening their dissemination. This project will use controlled laboratory experiments to simulate the movement of microplastics across different environments and quantify the survivability of resistant pathogens within these different contexts. The findings will be directly relevant to the wastewater industry and environmental policymakers, whilst also introducing a critical public health perspective into ongoing discussions on microplastic pollution.

Dr Nick Royle

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I'm a behavioural and evolutionary ecologist and conservation biologist who has worked on parental care evolution and organismal adaptation to environmental change for over 30 years in a variety of species in the lab and field, particularly burying beetles, with a focus on understanding how the resolution of conflicts can achieve cooperative outcomes and facilitate social evolution. My research also concerns the ecology and conservation of invertebrates, especially beetles, in the wild in the UK including assessing the impacts of veterinary medicines and other environmental stressors on dung beetle microbiomes, performance and ecosystem services and the role of habitat quality and connectivity on the population ecology of blue ground beetles. Consequently, a key component of my research is focused on understanding how to improve ecosystem resilience.

Ecosystem resilience through holobiont enhancement

All multicellular organisms are host to communities of microorganisms – their microbiomes – that have important health and fitness consequences for their hosts. Together, this co-evolved partnership can be understood as a single unit: a holobiont. Due to the extended metabolic capacity that microbial symbionts provide to hosts, the adaptability of holobionts to stressors is likely to be greater than just host alone. This offers a potential way to accelerate adaptation and improve resilience of multicellular organisms to environmental stressors by enhancing the alignment of interests between the microbiome and host, overcoming barriers to holobiont evolution. In this project we will test whether boosting fidelity of beneficial microbial symbiont transmission across host generations facilitates more effective host-microbe relationships and improves reproductive output of holobionts – burying beetles and their fungal and bacterial symbionts – in response to environmental stressors.

Ecosystem and species recovery in temperate rainforests through enhancement of blue ground beetle habitat resilience and connectivity

Targeted support of key species and improvements to habitat quality and connectivity provide important conservation mechanisms to boost resilience in managed ecosystems. Temperate rainforest is a globally rare habitat that has strongholds in Cornwall and Devon, albeit in small, fragmented pockets. Reconnecting and restoring these fragments to improve ecosystem resilience requires improved knowledge about fine-scale habitat suitability and quality for temperate rainforest species. Blue ground beetles are habitat specialists that are dependent on temperate rainforest and are key potential indicators of forest health and umbrella species, but little is known about the quality of the available habitat and its suitability for this and other important temperate rainforest species. This is vital to assess if habitat is to be reconnected and restored. This project would work with key stakeholders including Buglife and Dartmoor National Parks Authority to address these issues.

Dr Xavier Harrison

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I am broadly interested in how interactions between hosts and their resident microbes can determine resistance to pathogenic infection, and how microbiome resilience following disturbance can shape downstream host health. I think the fit with the EER space stems from the idea that communities of animal hosts comprise their own individual microbial communities that may respond differently to external perturbations. I think studying ecosystem resilience requires that we understand the processes that shape resilience of animal-associated microbiomes in tandem.

Host-Associated Microbiomes as Predictors of Disease Susceptibility in the Wild

Climate change and habitat modification are accelerating the emergence and spread of infectious diseases in wildlife, farmed animals and humans. Host-associated microbial communities act as a first line of defence against pathogen invasion, and so are a key component of population and species resilience to disease. However, to date we lack a comprehensive understanding of which traits of the microbiome are most important in structuring host resistance to infection at local and global scales. We will leverage hundreds of published microbiome datasets from a broad range of taxa including amphibians, birds and mammals combined with machine learning models to identify the factors that predict susceptibility to pathogens in wildlife. Addressing this knowledge gap will allow us to predict when and where the intensity of pathogen outbreaks is likely to be highest and so guide targeted conservation interventions.

Prof. Ben Raymond

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My research interests have focussed on applying evolutionary ideas to applied problems- historically this has centred on evolution of resistance and evolution of virulence. This experience is well suited to addressing the problem of how we might improve the fitness of organisms subject to anthropogenic change. Much of my research has been on insects and microbial pathogens of insects, these are important groups in terrestrial ecosystems and make tractable study systems for experimental evolution.

Experimental evolution of insect natural enemies

Insect natural enemies such as fungal pathogens can play an important role in the population dynamics of their hosts and are widely exploited as environmentally-friendly pest control agents. Nevertheless, anthropogenic contaminants, climate change and the microclimates of the built environment pose a wide range of challenges for these microorganisms. Contamination from broad spectrum fungicides applied for the control of plant pathogens seriously impedes the action of pest management products while replication and action of insect pathogenic fungi is strongly temperature limited. This project will explore the potential for the experimental of improved fungicide resistance and/or higher thermal optima in a fungal pathogen such as *Beauvaria bassiana*.