



# QUADRAT ANNUAL SCIENCE MEETING

10 OCTOBER 2023

1495



UNIVERSITY OF  
ABERDEEN



QUEEN'S  
UNIVERSITY  
BELFAST



Natural  
Environment  
Research Council

## Welcome

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At the heart of any PHD Programme is partnership. The players in this partnership include students, supervisors, stakeholders, schools, institutions, projects, funders and many more.

When we launched QUADRAT, it was about an opportunity for new forms of science, new collaboration and enhancing partnerships. In a world of growing uncertainty constricted by economics, conflicts, and emerging challenges we will always be stronger through partnership.

Let's use this meeting to become better scientists through this partnership by meeting new colleagues, sharing ideas, speaking about science and non-science issues. Let's embrace the opportunities brought about through our annual science meeting and respect the values and beliefs of others.

The bonds of environmental-based research between the University of Aberdeen and Queens University Belfast continue to grow as we welcome our fifth cohort. We have nearly one hundred students covering a diverse range of projects, field locations, techniques, and people. This is the strength of QUADRAT.

We continue to invest in people and to offer unique, valuable opportunities through our partnership.

Engage, interact but most importantly enjoy and value this event.

**Professor Graeme I Paton & Professor Jenny McKinley, Quadrat Directors**  
October 2023



## Programme: 10 October 2023

09:30 - 09:45 Welcome and Introductions

### 10:00 - 12:15 **Session 1: Student Presentations**

10:00 - 11:00	Rosalin Simpson Karendeep Sidhu Annette Raffan Michael O'Connor	Ethan Ross Christina Rueda Uribe Tilly Scott Nathanael Litlekalsoy
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11:00 - 11:30 **Break**

11:30 - 12:15	Ryan Weir Catherine Finn Alexander Allenby	Delmar Diesel Will Hancock-Evans Cian McAuley
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12:15 - 14:00 Lunch and Posters

### 14:00 - 15:30 **Session 2: Student Presentations**

Daniel Coathup David Hatton Sarah Ferrandin Hazel Mosley Amy Lally Connie Baker-Horne	Jyothi Basapathi Raghavendra Lucy Ashpitel Annette Salles Gosse Bootsma Molly Crowe Anna Kellner
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15:30 - 16:30 Internship Information and Placement Talks

16:40 - 17:00 **Closing Remarks and Prizes**

## Rosalin Jane Simpson

### EXPLORING GENOMIC SIGNATURES OF PREDATORY LIFESTYLE CONVERGENCE IN ACARI MITES

Supervisors: Marius Wenzel, Alan Bowman and Caroline Meharg



#### Abstract

The evolutionary transition from a free-living to a parasitic lifestyle has occurred many times throughout the tree of life, from protozoan parasites to parasitic worms and arthropods. Within the mite arthropods (Acari) parallel evolution of a parasitic lifestyle has occurred across distantly related species, yet some predatory species have remained, representing the ancestral lifestyle. However, the genetic basis of this repeated evolution of a predatory lifestyle remains unknown.

Here we examine the rate of nucleotide substitutions in genome-wide protein coding genes of predatory Acari lineages to identify signatures of selection (dN:dS ratios) within and across predatory families. Our comparative analysis of 36 Acari genomes highlights 1213 genes under positive selection (dN:dS >10;  $p < 0.05$ ) in both predatory Acari compared to parasitic, herbivore and free-living lifestyles. A further 808 positively selected genes were identified solely in the laelapidae predatory family and 3627 genes only in the main predatory family Phytoseiidae. These genes undergoing positive selection in the predatory mite species will be functionally annotated to explore the physiological and evolutionary processes underpinning this key evolutionary transition.

Predatory mites are emerging biological controls with wide applications as sustainable alternatives to traditional biocide control practices. These novel insights into the genomic basis of predatory mite ecology will help the advancement of these Acari species as successful biological control agents and in turn manage conservation threats caused by traditional agricultural practices. The genes identified in this study may be used as markers to improve and monitor breeding programs for biological control agents.

## Ethan Ross

### ADVANCES IN DNA BARCODING USING OXFORD NANOPORE SEQUENCING FOR MONITORING SCOTTISH SEAGRASS BIODIVERSITY

Supervisors: Kara Layton, Julia Sigwart and Stuart Piertney



#### Abstract

Seagrasses and their species-rich communities provide vital ecosystem services including blue carbon storage, coastal protection and supporting fisheries but have recently faced global declines. Species richness is a critical factor in the ecosystem functions which underpin these services but remains difficult to estimate using traditional survey methods. Given this, seagrass beds are ideal candidate habitats to monitor with environmental DNA (eDNA) metabarcoding methods which use traces of DNA released by resident organisms to identify the species present on a habitat. However, detection using these methods relies on a pre-existing reference library of DNA sequences from known species.

This talk will focus on the first chapter of the project which focusses on generating reference sequences for the macroinvertebrates which inhabit the subtidal seagrass beds off the west coast of Scotland. Over 500 macroinvertebrates have been collected over the past two years, representing 120+ species. Specifically, I will focus on a recent methodological comparison between two different sequencing technologies, Sanger, and Oxford Nanopore for generating reference sequences at scale.

This work contributes to ongoing efforts to advance DNA barcode reference libraries for UK marine invertebrates. Additionally, it will improve identification of resident species using eDNA metabarcoding in latter stages of this project with the goal of establishing biodiversity baselines for these vital habitats.

## Karendeep Kaur Sidhu

### HEATWAVES DURING EARLY DEVELOPMENT HAVE LONG-TERM CONSEQUENCES FOR PARENTAL CARE IN ADULTHOOD

Supervisors: Lesley Lancaster, Paul Caplat, Greta Bocedi  
and Natalie Pilakouta



#### Abstract

Heatwaves are becoming more common due to climate change. Species can respond to this thermal stress through rapid behavioural changes. Specifically, parental care can increase reproductive success by buffering against thermal stress, but the ability to provide parental care may also be influenced by prior exposure to high temperatures. However, the effects of heatwaves during early development on parental care in adulthood have not yet been tested.

Here, we address this gap in our knowledge using the burying beetle *Nicrophorus vespilloides*, an ectotherm model system with facultative biparental care. We exposed juveniles to a heatwave event (3 days at 25°C) or control temperature of 18°C and subsequently measured their parental care behaviour, reproductive success, and offspring fitness.

More females, but not males, from the heatwave treatment provided care than those in the control treatment, but there was no difference in reproductive success or offspring fitness. Our findings suggest that heat waves during early development can have long-term impacts on parental care.

## Cristina Rueda-Uribe

### NOVEL USES OF OLD TECHNOLOGIES: AN AUTOMATED RADIO TELEMTRY SYSTEM TO INFER HUMMINGBIRD MOVEMENT IN TROPICAL MOUNTAINS

Supervisors: Lesley Lancaster, Isabella Capellini, Kara Layton  
and Justin Travis



#### Abstract

Understanding animal movement patterns is crucial to protect landscapes effectively. Yet there are still challenges in tracking very small animals and accessing remote locations, despite the advancement of tracking technologies. To generate tracking data of high-mountain hummingbirds in the tropics, we set up an automated radio telemetry system (ARTS) inside Chingaza National Park in Colombia. The ARTS grid covers approximately 1 km<sup>2</sup> of a valley with four main vegetation types, and is made up of 46 receiving nodes and a central antenna.

The receiving nodes continuously monitor for radio signals in the area and communicate with the central antenna where data is downloaded. Radio transmitters equipped with a solar panel transmit a radio signal every 2 seconds at 433 MHz when there is light, whereas transmitters that do not have a solar panel but instead depend on battery emit a signal at the same frequency every 60 seconds and last approximately 3 months.

Given that there is a relationship between signal strength and distance, locations of transmitters is estimated by tri- and multi-lateration. The localization error caused by multiple factors (e.g. interference from vegetation and topography, weather conditions, variation in transmitter strength and receiver capacity) may be reduced with machine learning algorithms. We have deployed 0.35 g transmitters on 11 hummingbirds from two species (Great sapphirewing and Bronze-tailed thornbill) and obtained data of individual movement at a fine temporal scale.

The successful installation and testing of the ARTS grid inside the protected area gives the opportunity to track other small animals such as rodents, bats, amphibians, reptiles and other birds in the highly endemic ecosystems of paramo and high-Andean forest for the first time. Also, this project has engaged official environmental agencies and local researchers in generating movement data to inform conservation practices.

## Annette Raffan

### WICKED WICK OF THE WEST; WHY NEIGHBOURHOOD MATTERS FOR WATER MOVEMENT AT THE ROOT-SOIL INTERFACE OF TIMOTHY GRASS

Supervisors: Paul Hallett, Kenneth Loades and Mark Emmerson



#### Abstract

At the root-soil interface, many grass species like timothy form a 'rhizosheath'. Rhizosheaths are composed of soil particles which stick to the roots due to root hairs and soil-binding root exudates. The rhizosheath is currently understood to be an advantage under low phosphorus and low water availability. But rhizosheath functionality and structure is not fully understood, especially in regards to its impact on soil properties in the context of a plant community. Therefore we question whether the rhizosheath is a competitive adaptation to quickly wick water to where it is needed most in a plant's root system. For a drought-stricken plant, this phenomenon would be advantageous, lest a more competitive 'wicked wick of the west' steals water first.

We developed a dry root, 'wick test' to compare timothy (*Phleum pratense* L. cv. Comer) rhizosheath behaviour when grown as a monoculture, and when grown in the presence of a 'more wicked wick of the west'; chicory (*Cichlorium intybus* cv. Puna II). We altered soil phosphorus, to manipulate competition and rhizosheath formation.

Initial soil wicking (sorptivity) rates for roots were 1000x higher than previously reported for soil. There was a stronger impact of chicory on timothy rhizosheath properties than phosphorus. If chicory was present, timothy roots had a smaller rhizosheath yet water sorptivity increased by around 25% per unit area.

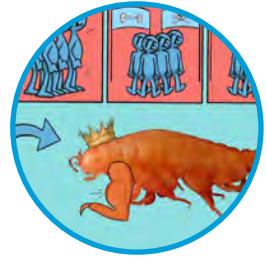
In summary, this highlights timothy grass has an ability to manipulate its root-soil interface to improve water movement in a competitive environment. By creating a faster-wicking rhizosheath for its size, timothy can mitigate the presence of chicory as a 'wicked wick of the west'. It emphasises the importance of understanding community-level interactions on soil structure development.



## Tilly Scott

### THE ROLE OF TRANSPOSABLE ELEMENTS IN THE EVOLUTION OF DEEP-SEA AMPHIPODS

Supervisors: Stuart Piertney, Marius Wenzel and Sarah Helyar



#### Abstract

The deep sea is an underexplored and poorly understood extreme environment, with immense hydrostatic pressure, near-freezing temperatures, and limited food resources. Despite the extreme environmental conditions, amphipods colonised the Abyssal and Hadal zones after the last deep-sea mass extinction. However, the evolutionary mechanism that underpins the adaptation of amphipods to the deep ocean is unknown.

Previous work proposed transposable elements (endogenous mobile genetic segments) as the evolutionary mechanism because deep-sea amphipods show genomic obesity. Genome sizes range from 3.97Gb to 34.02Gb, larger than most animals. Here we examine transposable element abundance and diversity, to consider their evolutionary role.

Due to the difficulties associated with getting high-quality DNA from deep-sea animals and the size of the amphipod genomes, only two RADseq data sets and one genome skim exist for deep-sea amphipods. However, from this limited data, we show that over 70% of deep-sea amphipod DNA sequences are transposable elements, a very high proportion and far more than shallow-water amphipods. Transposable element activity has likely increased the genome size of deep-sea amphipods. Transposable elements in the LINE order appear to have had the greatest proliferation and impact on the evolution of deep-sea amphipods.

Finally, we show that recent TE activity has shaped deep-sea amphipod evolution and that TE are likely active currently. Previous research has linked protein coding gene duplications with transposable element activity in animals. Several protein families, which likely play an important role in survival at extreme hydrostatic pressures, are expanded in deep-sea amphipods. Future work will examine the position of these genes in comparison to TE. This work adds to a growing body of evidence for the role of transposable elements in adaptive evolution. With whole genome sequencing of deep-sea amphipods, we will better understand the evolutionary impact of transposable element activity.

## Michael O'Connor

### CONSERVATISM IN ECOLOGICAL AND COMPETITIVE TRAITS: PHYLOGENETIC PATTERNS TO INFORM ASSEMBLY OF NOVEL COMMUNITIES IN DAMSELFLIES (ODONATA: ZYGOPTERA)

Supervisors: Lesley Lancaster, Paul Caplat, Erik Svensson and Beatriz Willink



#### Abstract

Range shifting, a common response to climate change, can lead to novel interactions between range shifting species and local endemics, the outcomes of which can be potentially damaging for local biodiversity. Understanding the process of species community assembly, which dictates whether newly introduced species can coexist alongside established species, is therefore paramount to understanding the impacts of range shifting. Phylogenetic patterns of trait conservatism have often been used to inform community assembly under competition, with conservatism of niche traits thought to lead to phylogenetic overdispersion of communities shaped by stabilizing forces, whereas conservatism of competitive traits predicts underdispersion of communities shaped by equalizing forces.

Here we investigate the conservatism of competitive vs. niche traits in the damselfly superfamily Coenagrionoidea (Odonata: Zygoptera), to determine the likely community assembly process of novel competition in response to range shifting in this group. Odonates are among the most rapidly range shifting of all insect clades, and previous research indicates that competitive exclusion in impacted communities may be mediated by competitive rather than niche traits. Damselfly morphological and behavioural traits were split into two groups, those pertaining to niche use and those contributing to competitive ability, and were modelled for both phylogenetic signal and more widespread trait conservatism.

We found that competitive traits display strong phylogenetic signal, showing high values of Pagel's lambda and greater proportions of nodes evolving at BM (Variable Rates model). Niche traits exhibited stronger stabilising tendencies, displaying strong selective forces towards phylogeny-wide trait optima, returning high alpha-values from OU models. These results suggest that while distantly related species will have similar ecological requirements, competition will be better balanced between closely related species, predicting a phylogenetic clustering pattern to competitive outcomes following range shifting.

## Nathanael Johannesen Litlekalsoy

### INCORPORATING FUNCTIONAL GENOMICS INTO INVASIVE ALIEN SPECIES MODELLING USING EXOTIC HARLEQUIN LADYBIRD (*HARMONIA AXYRIDIS*): FROM GENES TO COMMUNITIES

Supervisors: Fabio Manfredini, Jaimie Dick and Greta Bocedi



#### Abstract

In the UK, Harlequin Ladybirds negatively impacts the abundance of seven native ladybird species due to a competitive feeding advantage. Functional responses used to estimate feeding rates are time consuming and subject to local variation, but likely have underpinning molecular processes that can provide more consistent measures on a larger scale.

Here we present work on combining functional responses and functional genomics with IAS impact modelling. Starved adult female Harlequin Ladybirds were subjected to three hunting treatments: normal hunting, prey detection without predation, and without prey detection or predation, before they were processed for gene expression analyses.

Harlequin Ladybird feeding responses varied widely and will be matched to differential gene expression analysis. To test the viability of the method in field conditions, functional responses were taken along a transect reflecting the history of invasion of the species in the UK. Functional genomics appears promising to enhance IAS impact modelling.

## Ryan Weir

### PLANT ROOT EXUDATE METABOLOME REVEALS TEMPERATURE DEPENDENT PARASITE REPELLENTS

Supervisors: Aaron Maule and Julianne Megaw



#### Abstract

Plant Root Exudate (PRE) is an adaptive composition of sugars, volatile organic compounds and secondary metabolites. The specific composition of PRE is dynamic and fluctuates depending on the temperature a plant is grown. PRE is the sessile plants primary method of top-down control over its environment and has been demonstrated to influence relevant soil organisms such as plant parasitic nematodes (PPN) and plant growth promoting bacteria (PGPB), understanding this pathway offers an opportunity to find novel compounds for parasite control.

Here GC-MS analysis revealed significant changes in the composition of PRE collected across a temperature range (18°C, 23°C, 28°C). In-vitro behavioral assays have also been used to assess the impact of this PRE collected across a temperature range on PPN chemo-sensation as well as PGPB chemotaxis and biofilm formation. Exploration of PPN chemosensory response to these PRE samples showed that PRE collected at 28°C was significantly more attractive to the nematode *Meloidogyne incognita* than that of 18°C ( $P \leq 0.001$ ). Conversely PRE collected at 18°C was significantly more attractive than that of 28°C ( $P \leq 0.01$ ) to *Globodera pallida*. Significant impacts on the behavior of PGPB was also found.

Analysis of PRE revealed significant differences in the metabolome profile. Of interest was compounds for which concentration showed linear correlation with temperature. These compounds were selected and the impact they had on soil organisms was investigated. Not all compounds had an impact on. However across all testing, the compound 3,3-dimethylhexane proved to be a PPN repellent. When spiked into an attractive control PRE sample it made the sample repulsive shifting the chemosensory index for *M. incognita* from +0.27 to -0.26 ( $p < 0.01$ ) in the presence of 100µM and for *G. pallida* from +0.1 to -0.07 ( $p < 0.05$ ) at 100µM. Metabolite 3,3-dimethylhexane also had significant impacts on PGPB chemotaxis and biofilm formation.

## Delmar Diesel

### ECOLOGY, BEHAVIOURS, AND ENERGETIC COSTS OF FREE-RANGING AFRICAN LIONS (*PANTHERA LEO*) IN AN ARID, RESOURCE-POOR AREA USING REMOTE SENSING TECHNOLOGIES

Supervisors: Nikki Marks, Mike Scantlebury, Catherine Hambley



#### Abstract

African lion (*Panthera leo*) populations face many challenges to their survival. Habitat loss, climate change and human encroachment have led to the decline of the species in many regions and current populations are heavily fragmented and relegated to a fraction of the species' historical range. These challenges underscore the urgency of studying and conserving this iconic species. In this context, lions of the Kgalagadi Transfrontier Park (KTP), South Africa stand out as a remarkable and resilient population, uniquely adapted to survive in an extremely resource poor and arid environment. Investigating the ecology, movements and behaviours of these lions is fundamental in understanding how they are able to maintain a stable population under such extreme conditions.

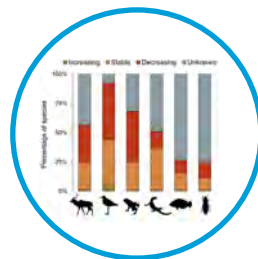
Thirteen lions from four prides within KTP were fitted with GPS loggers, tri-axial accelerometers and tri-axial magnetometers for a period of approximately 8 months, representing the first occasion in which this lion population has been the subject of long-term remote sensing data collection. This project utilises this remotely sensed data to investigate various aspects of KTP lion ecology. For instance, analysis of seasonal home ranges variation across individuals and prides offers insights into how habitat utilisation responds to environmental factors such as aridity and prey availability. Additionally, remote sensed data has been used to investigate the effects of conservation practices such as the identification of behaviours and movements inside and outside of the KTP protected area.

The movements, behaviours and energy expenditure before and after translocations of problematic lions has also been investigated. This not only advances our understanding of this lion population's adaptability to extreme conditions but will also lay the foundation for more effective conservation management practices for the species in the face of escalating environmental challenges.

## Cat Finn

### MORE LOSERS THAN WINNERS: INVESTIGATING ANTHROPOCENE BIODIVERSITY DECLINE USING POPULATION TREND DATA

Supervisors: Daniel Pincheira-Donoso, Lesley Lancaster and Paul Caplat



#### Abstract

The global-scale decline of animal biodiversity represents one of the most alarming consequences of human impacts on the planet. Quantifying this extinction crisis has traditionally relied on the use of IUCN Red List conservation categories assigned to each assessed species – revealing that a quarter of the world's animals are threatened with extinction, and ~1% have been declared extinct. However, extinctions are preceded by progressive population declines through time that leave signals which can alert us about the trajectories of species towards extinction. Therefore, focusing exclusively on conservation categories, without consideration of population trends, may underestimate the true extent of ongoing extinctions across nature.

We used population trend data for >71,000 animal species (spanning mammals, birds, reptiles, amphibians, fishes and insects) to provide a comprehensive global-scale assessment of the diversity of all four population trend categories (declining, stable, increasing and unknown). We revealed a widespread global erosion of species, with 48% (23–76%) in decline, 49% (23–76%) stable and only 3% increasing, with ranges representing lower and upper bounds due to species with unknown population trends.

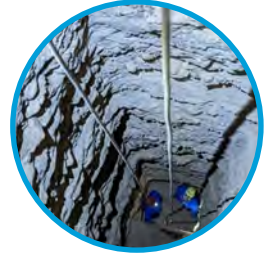
Geographically, we revealed that population declines tended to concentrate around tropical regions, whereas stability and increases showed a tendency to expand towards temperate climates. Importantly, we found that for species currently classed by the IUCN Red List as 'non-threatened', 33% were declining. Collectively, our assessment shows that the Anthropocene extinction crisis is undergoing a biodiversity imbalance, with levels of declines (a symptom of extinction) greatly exceeding levels of increases (a symptom of ecological expansion or recovery) for all groups.

This work contributes a further signal indicating that global biodiversity is entering a mass extinction, with ecosystem functioning, biodiversity persistence, and human well-being under increasing threat.

## Alexander Allenby

### A METAGENOMIC SURVEY OF A CHEMOAUTOTROPHIC CAVE ECOSYSTEM

Supervisors: Deepak Kumaresan, Jean-Christophe Comte  
and Rory Doherty



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#### Abstract

Movile Cave is a unique subterranean ecosystem evolutionarily and physically isolated for ~5 million years and sustained by microbial primary production. Chemoautotrophic microbes derive energy from the oxidation of hydrogen sulphide and methane to form the basis of the food web.

Here we apply high coverage shotgun metagenome sequencing to the micro-niches of Movile Cave, namely the microbial mat, sediment and wall biofilm. The taxonomic diversity of these micro-niches were assessed by read classification using Kaiju.

The relative abundance and diversity of biogeochemical cycling genes were determined using a custom pipeline incorporating protein-level assembly using PLASS, homologue detection using HMMER3 and phylogenetic reconstruction. Metagenome Assembled Genomes (MAGs) were also generated and were both taxonomically and functionally characterised.

## Will Hancock-Evans

### GREENING CITIES; HOW STREET TREES, AND OTHER TREES CAN IMPROVE CONNECTIVITY FOR BIODIVERSITY

Supervisors: Paul Caplat, David Burslem, Juliano Morimoto and Greg Keeffe



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#### Abstract

Urban green spaces (UGS) such as parks and gardens are biodiversity hotspots in cities, providing resources and habitat for invertebrate species. Whilst there is a wealth of literature on these systems in isolation, their overall contribution to urban biodiversity and their level of connectivity remains underexplored.

Street trees are a ubiquitous form of UGS, that individually contribute little to urban ecology compared to larger UGS. However, they permeate areas where spatial limitations typically prevent the installation of larger green spaces. As such, they might act as corridors or stepping stones, linking UGS in functional networks.

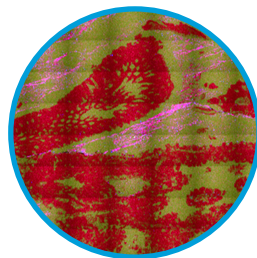
Here we examine the efficacy of street trees in improving habitat connectivity between UGS, shedding light on the current biodiversity and landscape ecology of this system, behavioural responses to common barriers, and mapping and modelling of connectivity networks, both current and under proposed urban afforestation schemes.



## Cian McAuley

### CORAL BEARING BIOHERMS FROM THE LATE DEVONIAN OF SOUTH DEVON: EXPLORING THE LIMITS OF PALAEOZOIC CARBONATE BUILDUPS

Supervisors: Alex Brasier



#### Abstract

Modern scleractinian corals require a specific set of environmental conditions in order to thrive, namely clear, warm, and high energy waters. In contrast, Palaeozoic corals were often most comfortable in calm waters, settled on muddy substrates. Yet there must have been some limit to the depth and sedimentary environment that they could tolerate. To explore this, we examined the Devonian fossiliferous rocks of South Devon, UK. Despite historical palaeontological records dating from this, the type area of the Devonian System, these successions have been overlooked for many years, with little to no geochemical investigation undertaken until now.

Here we report the results of fieldwork, optical and electron microscopy, and elemental and stable isotope geochemistry of Frasnian coral-bearing bioherms from Saltern Cove, Paignton, to deduce the palaeoenvironmental circumstances under which the corals grew, and those that may have resulted in their demise. The studied bioherms were up to 5 m across and 1.5 m thick. They are preserved as interbedded layers of cemented limestone (2-30 cm), draped in a red siliciclastic mudstone facies (1-15 cm) that is also the dominant lithology immediately above and below the bioherms.

The muddy host-rock lithology (coupled with a lack of stromatoporoids) suggest a relatively deep water palaeoenvironment, associated with significant inputs of muddy, terrestrial siliciclastic sediment. Corals within the cemented limestone of the bioherms often appear to be in situ, with both branching and encrusting tabulate corals, while corals in red mudstone are often loose and may have been washed in from shallower platforms during storms. On some biohermal horizons, most of the corals have been partially or fully replaced by diagenetic silica, whereas other corals remain calcitic. While the growth of any individual bioherm was able to outcompete mud deposition for some time, significant smothering of mud (20+ cm) appears to have been terminal. This suggests that Palaeozoic corals may have been quite resilient though not immune to terrestrial inputs.

## Daniel Thomas Coathup

### HOLOCENE DEVELOPMENT, CARBON ACCUMULATION, AND FIRE REGIME CHARACTERISTICS IN BOREAL FORESTS AND PEATLANDS

Supervisors: Dmitri Mauquoy, Maarten Blaauw and David Muirhead



#### Abstract

Peatlands are the largest terrestrial carbon store on the planet, containing almost one-quarter of the global soil organic carbon stock, with 90% of this store residing in boreal and subarctic peatlands. However fundamental questions remain regarding the carbon sequestration potential of boreal peatlands in response to rising atmospheric temperatures, shifting precipitation patterns, and increasing frequency and severity of fires. To understand how the peatland carbon stock may respond to changing climate and altered fire risk, it is vital to understand the impact of past climate changes on carbon accumulation.

This study will address the knowledge gaps highlighted through a high-resolution, multiproxy approach that will attempt to disentangle the drivers of carbon accumulation and reconstruct fire regimes across a range of mire types for the boreal region. To achieve this, a suite of established (plant macrofossils, testate amoebae, pollen, charcoal) and emerging (Raman spectroscopy) palaeoecological techniques are being employed. The reconstructions will be complimented with robust Bayesian-age modelling chronologies, developed using  $^{210}\text{Pb}$  and AMS- $^{14}\text{C}$  derived dates.

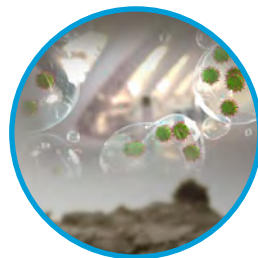
Further work will investigate long-term (centennial to millennial) fire regimes in boreal forests, given the importance of boreal forest fires and their ecological impacts. Fires are historically the key disturbance in boreal forests, and fire regime characteristics are a strong determinant of variations in forest structure and species composition. Yet, many studies project higher temperatures and longer growing seasons during the twenty-first century will increase the frequency and severity of boreal forest fires. Boreal forests comprise one-third of the global forest area and terrestrial carbon stock and hence changes in fire dynamics will have a substantial impact on global carbon emissions and radiative forcing.

This work will demonstrate the first attempt to utilise Raman spectroscopy and sedimentary charcoal together to reconstruct variations in Holocene fire frequency and intensity in the boreal forest of southern Finland.

## Jyothi Basapathi Raghavendra

### ASSESSING THE LOWER LIMITS OF LIFE DETECTION IN EXTREME ENVIRONMENTS USING NANOPORE TECHNOLOGY

Supervisors: Maria-Paz Zorzano, Deepak Kumaresan  
and Javier Martin-Torres



#### Abstract

The microbial world is central to all biotic and abiotic interactions and plays a prominent role in regulating the terrestrial nutrient cycling and atmospheric composition of climate-active trace gases. Throughout the evolution of Earth, microbial communities have adapted to different habitats, including extreme environments. The biosphere of Earth expands over the lithosphere, hydrosphere, cryosphere, and atmosphere. Some of these habitats have been poorly characterised, partly because of the low concentration of cells, and partly because of the technical difficulties of the study of some of these ecosystems. This is the case of the lithosphere (microbiome of rocks and soils), the briny liquid pools of the hydrosphere and the atmosphere (aerobiology), which have been investigated in the first half of this PhD.

The lowest detection limit of active life forms is a topic of interest for the study of biodiversity on Earth and the possible detection of life in the rocks of Mars. Deoxy ribose nucleic acid (DNA) being one of the incontrovertible biosignatures is an easy target, however due to its low abundance in certain environments, one of the biggest challenges is the ability to extract efficiently and characterise it without any amplification.

In this work, we describe a method of characterizing the low biomass in all three states of environments: bioaerosols (gaseous state), MMS-2 Martian soil simulant (solid state) and brine pool (liquid state). We demonstrate that an adapted sampling and extraction protocol, together with the analysis of the DNA sequence using MinION Nanopore sequencer allows for exploring the microbial taxonomic composition of habitats poorly described to date, whose metabolic pathways are also part of the carbon, water, and nitrogen cycle.

## David A. Hatton

### THE IMPACT OF CLIMATE CHANGE AND EXTREME WEATHER EVENTS ON CYANOBACTERIA BLOOMS IN LAKES

Supervisors: Helen M. Roe, Graeme T. Swindles and Alex Douglas



#### Abstract

Harmful cyanobacterial blooms (CyanoHABs) in freshwater systems have garnered increased public and scientific interest due to the potentially devastating impacts of their toxic secondary metabolites on biota. This has created significant impetus to elucidate the drivers of CyanoHAB occurrence, and to better understand the resilience of lakes to these toxic bloom events.

Dated sediment cores ( $^{210}\text{Pb}$ ,  $^{137}\text{Cs}$ ,  $^{14}\text{C}$ ) from shallow lake sites in New Brunswick, Canada, have been examined to explore relationships between past toxic bloom events and their controls. Multi-proxy sediment analyses (grain-size, Itrax-XRF; stable isotopes:  $\delta^{13}\text{C}$ ;  $\delta^{15}\text{N}$ ) were employed to explore the mechanistic links between the drivers of lake change (i.e. climatological stressors and catchment related disturbances) and past episodes of CyanoHAB development. Cyanobacterial responses were investigated using taxonomically specific sedimentary pigments and microcystin congeners, cyanobacteria-specific toxic metabolites that preserve in sediments.

Preliminary results show that cyanobacterial pigments and cyanobacteria-specific toxins have increased significantly in recent decades across the three lakes studied. In one site, microcystin congeners were detected intermittently throughout the upper 10 cm of the record (representing the last ca. 100 years), before increasing significantly in the upper section of the core towards the present day. These shifts in microcystin concentration broadly correlate with changes in pigment occurrence. Notably, the appearance of aphanizophyll, which indicates water quality degradation and a shift towards nitrogen fixing cyanobacteria, mirrors increases in total microcystins, and a significant spike in MC-LR and MC-RR. Further work is being undertaken to try to elucidate the mechanisms underpinning the drivers of CyanoHAB occurrence in these lakes.

These initial results demonstrate the utility of applying a palaeolimnological approach to reconstructing CyanoHAB events, providing an opportunity to significantly extend the inferences which can be made from water quality monitoring data alone. This may provide invaluable insights into how these lakes might respond to future stressors.

## Lucy Ashpitel

### THE GLACIER-CLIMATE HISTORY OF CORDILLERA PARIACACÁ AND CORDILLERA HUAYTAPALLANA, CENTRAL PERUVIAN ANDES, FROM THE LATE PLEISTOCENE TO HOLOCENE

Supervisors: Matteo Spagnolo, Brice Rea, Anshuman Bhardwaj and Donal Mullan



#### Abstract

In Peru, glacial meltwater is a crucial resource, supplying drinking water, hydroelectric power and irrigation. Peruvian glaciers are rapidly retreating, a trend which seems only set to continue as the outer tropics become hotter and drier. Cosmogenic exposure dating of moraines aids understanding of how glaciers have responded to past climate changes, which will help understanding of glacier response to present and future climate scenarios.

Glaciers in the Peruvian Cordillera Pariacacá and Cordillera Huaytapallana (approx. 11.5 °S), provide meltwater to millions. Since the 1970s, Pariacacá and Huaytapallana have experienced a 55.3% and 56% shrinkage in glacial mass, respectively. In order to contextualise this change, we need to look to past phases of glacial retreat. However, no chronology exists for the glacial history in either region. This study provides the first glacial geochronology based on <sup>10</sup>Be exposure ages of moraine sequences. The valleys sampled have successions of moraines that span in age from the Last Local Glacial Maximum to the late Holocene.

The Peruvian climate and glacial dynamics have been linked to variations in sea surface temperatures, the Intertropical Convergence Zone, and South American Summer Monsoon. The climate is also modulated by the Andean Mountain chain, which acts as a topographical barrier causing a rain shadow on its western flank. Contemporary climate studies suggest the western Andes, where Pariacacá is located, is influenced by the Pacific Ocean. Whereas, the eastern Andes climate, where Huaytapallana is situated, is dominated by Atlantic Ocean conditions. Initial results from Pariacacá, however, indicate palaeoclimate linkages to the Atlantic Ocean. Data from this study will help constrain the ocean and atmospheric controls on glacier mass balance in Peru, how the controls differ between the two sides of the Andes, and how they have developed over the past 40 ka.

## Sarah Ferrandin

### LAND-USE AND CLIMATE CHANGES DURING THE IRISH BRONZE AGE: WHAT CAN THE NITROGEN CYCLE TELL US?

Supervisors: Gill Plunkett, Kate Britton and Neil Ogle



#### Abstract

Isotope zooarchaeological research in Ireland has identified a sustained positive shift in the nitrogen stable isotopic values of faunal remains during the Middle to Late Bronze Age, which has been hypothesised to have been triggered by an intensification of farming (1750-800 BCE; Guiry et al., 2018, *Science Advances*). If true, the shift would represent an indelible human footprint in the geologic record. However, whether these region-wide changes were triggered by anthropogenic factors (such as deforestation or farming activities) or by natural climatic changes, has not yet been tested. Further investigation of the phenomenon is warranted because there is evidence for episodes of land-use and climate changes during the period of interest.

Focusing on samples from across Bronze Age Ireland, this paper will present results from a multi-proxy analysis of sedimentary records and herbivore remains that seeks to explore the context (and cause) of nitrogen isotopic changes identified in faunal remains in previous research. Ombrotrophic peat bogs obtain their nutrients from the atmosphere, meaning their stable isotopic values should reflect climatic fluctuations, unlike lake sediments, which should reflect both climate and land-use changes. In addition to carbon and nitrogen stable isotope measurements of sediment cores to pinpoint the timing of the shift in the isotope record, pollen (from lakes and peatlands) and testate amoebae analyses (from peatlands only) are used to reconstruct land-use and water-table fluctuations. Herbivore bone collagen stable isotopes have also been measured to extend the spatial distribution of the bone dataset presented by a previous study and to refine the timing of the change observed in the bone remains.

Through this multi-proxy study, we explore the inter-relationships between the nitrogen cycle, climate and human activity and consider whether there is a case for an early Anthropocene in Ireland.

## Annette Salles

### RESILIENCE AND ADAPTATION OF FIRST NATIONS COMMUNITIES IN CANADA TO DISAPPEARING WINTER ROAD INFRASTRUCTURE IN A CHANGING CLIMATE

Supervisors: Donal Mullen, Matteo Spagnolo and Gemma Catney



#### Abstract

In northern Canada, Arctic amplification has led to temperature increases of more than three times the global average, resulting in ever shorter freezing periods and winter road operations. The lack of access disrupts food and energy security, aggravates housing and education problems, and exacerbates the existing cultural deprivation of remote First Nation communities.

Historical analyses of temperatures, freezing degree days and ice thickness measurements suggest up to 30% more freezing degree days needed for the required ice depth, parallel to local thickness trends of -0.3 cm to -8.0 cm per decade. Future ice thickness under different socioeconomic scenarios will be determined using the lake model FLake, as proxy for winter road availability.

The physical analyses are complemented by the observations of traditional knowledge holders and Indigenous winter road users. Interview methods are co-designed with the communities involved and follow a decolonising approach to knowledge production with the aim of identifying historical, current, and anticipated changes in winter road infrastructure, their impacts on Indigenous communities and their adaptation options. As traditional economies contribute little to GDP, the study can add powerful evidence to enact policy changes otherwise guided solely by financial considerations.

## Hazel Mosley

### LANDSCAPES OF PRODUCTION: EXPLORING THE PALAEOENVIRONMENTAL CONTEXT OF STONE TOOL QUARRYING, MANUFACTURE, USE AND DEPOSITION ON NEOLITHIC SHETLAND

Supervisors: Will Megarry, Ed Schofield and Gill Plunkett



#### Abstract

Today the landscape of the Shetland islands, off the north coast of Scotland, is a patchwork of farmland, heath and blanket bog, but palynological studies suggest that during the Neolithic vegetation was much more diverse. Several sites in Shetland show values high of tree and shrub pollen, but due to the problem of wind transport researchers are circumspect about whether these really represent local woodlands, especially in the absence of plant macrofossils to corroborate pollen data.

In the last 10 years, new radiocarbon dates and reanalysis of Shetland archaeological sites long suspected to be Neolithic have suggested an early Bronze Age chronology for these sites, challenging previously held beliefs about settlement and land-use during the Neolithic and highlighting a gap in our understanding of this important period. More recently, radiocarbon dates from felsite stone tool quarries in the uplands of North Roe, north-west Mainland, and a cache of polished axes and knives at Modesty in west Mainland indicate extensive quarrying and distribution networks in the early to middle Neolithic. Although found throughout Shetland, felsite artefacts are concentrated on the Northmavine peninsula and adjacent areas of Mainland, reflecting both the natural presence of the raw material and the choices made by the Neolithic inhabitants regarding felsite working practices and networks of artefact distribution.

North-west Mainland has a wealth of Neolithic archaeology and limited palaeoecological coverage, something this project seeks to redress. The upland landscapes around the quarries are different to any sites previously studied in Shetland. Through analysis of pollen and non-pollen palynomorphs from new peat cores, targeting sites close to the felsite quarries and the hoard at Modesty, we examine the landscape context of this important industry and explore Neolithic land-use and vegetation change. This new data is integrated with existing palaeoecological studies to explore regional variations in vegetation.



## Gosse Bootsma

### DYNAMICS OF CARBON CAPTURE IN SCOTTISH AND IRISH PEATLANDS OVER THE PAST CENTURIES

Supervisors: Maarten Blaauw, Dmitri Mauquoy and Gill Plunkett



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#### Abstract

The project aims to improve understanding of how carbon was stored and lost over the last 500-600 years. This period is less well understood as most of it is covered by a radiocarbon plateau, complicating radiocarbon dating. The apparent difference in accumulation rates between the acrotelm and catotelm further complicates matters. By using improvements in radiocarbon dating, improvements in age modelling using Bayesian statistics, as well as other established methods, the project aims to overcome these barriers, looking at some Scottish and Northern Irish sites in particular.

In this talk I will give an overview of the project, discuss some initial results and talk about further plans.

## Amy Lally

### ENGLACIAL ESKER EVOLUTION AND PRESERVATION POTENTIAL: AN EXAMPLE FROM BREIDAMERKUJOKULL, SE ICELAND

Supervisors: Alastair Ruffell, Andrew Newton, Brice Rea and Matteo Spagnolo



#### Abstract

Directly observing glacial drainage systems (englacial and subglacial) poses challenges. The distribution, morphology, and internal structure of eskers can provide valuable information about channelised drainage and meltwater processes. Additionally, studying contemporary glacial landforms establishes modern analogues, enhancing our understanding of palaeo-glaciated landscapes.

This work presents the annual evolution of an esker melting out of the Breiðamerkurjökull ice margin, SE Iceland. Changes in esker morphology were mapped over a 1-year period using high-resolution unmanned aerial vehicle data. Ground-penetrating radar surveys were undertaken to examine the internal architecture of the esker and the drainage network within the surrounding glacier.

The crest morphology evolved from flat to sharp-crested, and the ice-cored esker's footprint expanded 5.7 times in response to post-depositional processes. An upglacier moulin likely supplied meltwater to the englacial channel. Upglacier debris-filled basal hydrofractures, which formed by pressurized subglacial meltwater, provided sediment to the conduit. Englacial esker deposition may become more common at downwasting snouts, as englacial meltwater meets debris-rich basal ice and debris-filled structures.

The findings indicate that englacial esker preservation potential may be poor due to post-depositional slumping and meltwater erosion, which has implications for reconstructing glacial drainage systems using preserved landforms alone. The study highlights the value of high-temporal resolution data for quantifying morphological changes and refining glacial process-form models.

## Molly Crowe

### QUANTIFYING KELP DETRITAL PATHWAYS: WHAT IS POTENTIALLY LOCKED AWAY AS BLUE CARBON?

Supervisors: Dr Pal Schmitt, Prof Ursula Witte, Dr Billy Hunter, Prof Jaimie Dick, Dr Mánuis Cunningham, Dr Louise Kregting



#### Abstract

The aim of the project is to build a better understanding of the source to sink relationships between coastal standing stocks of kelp and detrital material in shelf sea sediments.

Firstly, eDNA in sediment and water samples was analysed using metabarcoding, detecting the presence of Phaeophyceae (kelp) in sediment, and work continues to achieve species-specific resolution for my three target species – *Saccharina latissima*, *Laminaria hyperborea* and *L. digitata*.

Secondly, a tank experiment is testing the effect of temperature and oscillatory motion on the release of Dissolved Organic Carbon (DOC) from whole-blade juvenile *S. latissima*.

Lastly, lipid composition is being investigated as a means of tracking the fate of my target species in shelf-sea sediment.

Fresh material of each species is collected in each season – Oct, Jan, Apr, July – to gain composition profiles for each species. Meanwhile, replicates of each species are decomposed in open flow-system buckets and sediment samples taken monthly for lipid analysis. This provides temporal data on the individual contribution of each species. Comparing these to lipid analysis of sediment collected in the Irish Sea shelf sea in both February and July will hopefully provide a picture of how the detrital material of these kelp species is moving around the Irish sea.

Overall, these methods aim to highlight the sink locations of kelp detrital material in the Irish Sea and the processes impacting the decomposition and therefore transport of this material once it leaves the coastline.

## Anna Kellner

### REWILDING AND THE RETURN OF INTERACTING MESO-PREDATORS: UNDERSTANDING, MODELLING AND MONITORING PREDATOR-PREY DYNAMICS IN NON-EQUILIBRIUM ECOSYSTEMS

Supervisors: Xavier Lambin, Thomas Bodey, Paul Caplat and Andrew Stringer



#### Abstract

Investigating community assembly at a landscape level requires data from a range of species across a variety of systems. Kielder Forest, an intensively managed commercial forest characterised by spatio-temporal heterogeneity, provides a model system to compare human-modified landscapes to more natural sites. Species present in the forest include pine marten *Martes martes*, goshawks *Accipiter gentilis*, tawny owls *Strix aluco* and field voles *Microtus agrestis*, for which unique long-term datasets on colonisation, performance and cycles exist.

Distribution in resource use along a productivity gradient will be quantified using camera traps, artificial nest predation, and food supplementation with carrion from deer culls. Preliminary results suggest pine marten resource use is unevenly distributed. Future work will investigate the interaction of competing mammalian predators and the potential impact of this on tawny owl populations.

Overall, this project will provide insight into the dynamics of multiple species within anthropogenic landscapes to inform management methods.

## Connie Baker-Horne

### THE EFFECTS OF MATERNAL STRESS ON MATERNAL INVESTMENT AND OFFSPRING SURVIVAL IN THE FALLOW DEER *DAMA DAMA*



#### Abstract

Stressors are ever increasing in the natural world from human wildlife conflict to extreme weather events. Stress and its associated hormones (ie- glucocorticoids-cortisol) can be particularly damaging in its chronic form to pregnant individuals, inducing a range of detrimental effects to developing offspring known as maternal stress effects. Whilst maternal stress has been studied broadly in humans, rodents and domestic animals, there is limited research that explores this issue with mammals who have longer gestation periods living amongst a wild setting. Therefore, my research has focused on studying maternal stress in a free-roaming herd of fallow deer *Dama dama*, studying 61 key individuals over two years, with the overall aim to address how stress throughout pregnancy impacts offspring.

The research has been completed using both behavioural and physiological measures, where 1200 hours of behavioural recordings have been used to measure stress responses through the study of vigilance and flight initiation distance. Simultaneously the research has developed a non-invasive means of collecting hair from unique pregnant females to test their hair cortisol levels, whilst also measuring hair cortisol from their respective fawns. The project has further explored maternal investment behaviours related to maternal and offspring cortisol and finally has explored the relationships between maternal stress hormones and fawn stress using hair samples.

This research is a major contributor towards the field of maternal stress, being the first of its kind in a large free roaming mammal and provides new insights into enhancing deer herd management in particular for females.

## Alusia Malinowska

### MULTITROPHIC RESPONSES TO MULTITROPHIC CONSERVATION INTERVENTIONS: NON-TARGET SPECIES RESPONSES TO BIOLOGICAL ERADICATIONS ON AN ISLAND

Supervisors: Neil Reid, Thomas Bodey and Jaimie Dick



#### Abstract

Small offshore islands provide critical refuge for seabirds and ground-nesting birds. They are however threatened by the introduction and subsequent incursion of non-native predators. To protect biodiversity and counter further species decline, island eradication projects are increasingly being undertaken as a conservation intervention. However, while the eradication of non-native species is beneficial for the target species of conservation concern, it has broader implications across an island's entire trophic structure. This includes potentially significant short-term population shifts in non-target species, such as lagomorphs and various breeding birds, resulting in potential trophic cascades as well as alterations in behaviour.

The LIFE Raft program is an EU funded, RSPB led, multitrophic eradication project targeting brown rats and feral ferrets on Rathlin Island. Collaborating with LIFE Raft, this project examines the short-term community-wide impacts of, and responses to, eradications, by collecting data on Rathlin Island using a range of remote sensing technologies during a three-year period encompassing before, during, and after the eradication process. Camera traps will be used to measure population density and distribution of lagomorphs and birds, and acoustic recording to quantify changes in wader vigilance behaviour (alarm-calling) over the eradication. In person surveys will also be used to monitor breeding success in ground nesting Common eider. This approach will facilitate an assessment of numerical and density changes, spatial and temporal distributions, habitat utilization, behavioural responses, and hatching success. This will in turn provide insight into the immediate and short term impacts of the eradication on a wide range of vertebrate taxa.

## Aya El Samad

### UNDERSTANDING SOCIAL VALUES ON LOW CARBON SUB-SURFACE TECHNOLOGIES IN THE UK AND AUSTRALIA

Supervisors: Tavis Potts, Clare Bond and Wesley Flannery



#### Abstract

Since the Paris Agreement was signed in 2015, many nations worldwide have been speeding up to set net zero targets for 2050, amongst them are the UK and Australia. The net zero strategies for both countries are reliant on the utilization of different low carbon sub-surface technologies including, Carbon Capture, Utilisation, and Storage (CCUS) technologies. However, CCUS faces several challenges including public perceptions which impact project deployment. This research aims to map the level of public understanding and social acceptance of CCUS technologies in both the UK and Australia, specifically in the North East of Scotland and Western Australia.

Employing Q methodology, this study analyses key stakeholder perceptions to uncover the intricate relationship between perception and CCUS adoption. By bridging gaps in current knowledge, the research provides insights into how perception influences CCUS deployment.

The findings will contribute to both an empirical understanding of public attitudes toward CCUS and the efficacy of Q methodology for mapping perceptions. Such insights are crucial for shaping effective policy frameworks and fostering collaborative net zero strategies in the journey towards a just energy transition.

## Cherie Edwards

### THE DYNAMICS OF BRONZE AGE UPLAND SETTLEMENTS IN IRELAND AND NORTHERN BRITAIN: A COMPARATIVE PERSPECTIVE

Supervisors: Dirk Brandherm, James O'Driscoll and Gill Plunkett



#### Abstract

The Irish and Northern Britain Bronze Age artifact record is rich in finds of extraordinary beauty and artisanal skill, yet upland settlement sites that offer reliable absolute dating can be elusive, and many sites have traditionally been dated through finds typology or relative dating. Developer-driven archaeology datasets and continued improvements in scientific techniques have helped to expand our knowledge, but most studies have focused on lowland sites or high-profile hillfort sites. In upland areas, when compared against palaeoecological data, the settlement picture that emerges shows contradictions: palaeoecological studies seem to indicate simultaneous settlement expansion and contraction during periods of climate change. Refinement of settlement chronologies in locations over 200m ODN from Ireland and Northern Britain would permit more reliable comparative analysis against these climatology datasets.

The need to understand how past societies dealt with major climate events has been acknowledged by scholarship, however the existing archaeological record in most upland areas of Northern Britain and Ireland is not granular enough to avoid false 'cause and effect' conclusions and requires refinement to generational levels where possible. This project is an effort to generate a more granular and refined chronology through expanding existing chronologies of selected archaeological zones using radiocarbon dating of untested archived samples, new samples and re-evaluation of finds by typologies.

The resultant datasets will utilize multivariate comparative analysis to draw larger conclusions about Bronze Age upland settlement dynamics in Northern Britain and Ireland during periods of significant observable climate events.



## Danni Thompson

### COLONY AND INDIVIDUAL-LEVEL VARIATION IN FORAGING BEHAVIOUR

Supervisors: Thomas Bodey, Beth Scott, Ana Payo-Payo,  
Al Baylis and Jaimie Dick



#### Abstract

Individual-level mechanisms are important for understanding ecological, demographic and evolutionary processes. Phenotypic differences can lead to individual specialisation, particularly regarding resource use, with both behavioural and physiological variation affecting the ability of individuals to detect, capture, handle, and digest prey. This variation between individuals, if sustained, results in individual specialisation across the dietary niche. Both competitive interactions and environmental heterogeneity drive the prevalence of individual specialisation within populations, but few studies consider these drivers together.

The Falkland Islands shag *Leucocarbo atriceps albiventer* is an understudied nearshore, colonial species. Their widespread distribution across the archipelago in colonies of varying size, and with access to either oceanic or more inshore waters, allows for a natural experiment to differentiate between the effects of environmental heterogeneity and intraspecific competition as drivers of individual specialisation. By deploying GPS and TDR tags on breeding adults at multiple differently sized colonies, this study system provides a novel opportunity to identify the strength and extent of interactions between these key drivers.

Here we present preliminary results from three colonies, revealing high levels of individual variation in foraging travel behaviours resulting in significant colony-level differences in space use. Such information is central to informing the development of Falkland Islands Marine Managed Areas by identifying key foraging locations and, ultimately, prey species of importance for an important but poorly known nearshore predator.

## Diana Senovilla Herrero

### NEXT GENERATION BIOSENSING FOR ENVIRONMENTAL MANAGEMENT

Supervisors: Katrina Campbell, Lenka Mbadugha,  
Sarah Helyar, Heather Moore and Matthew Service



#### Abstract

Shellfish, especially when consumed raw like oysters, pose a foodborne illness risk due to build up of harmful microorganisms and natural toxins. Marine filter feeders such as live bivalve molluscs can bioaccumulate numerous contaminants, making their biomonitoring crucial. In Northern Ireland, environmental factors affecting shellfish production are monitored separately, often missing synergistic or antagonistic effects.

An initial review study analysed two decades of data (2001-2022) from the Food Standards Agency regarding Northern Ireland's coastal waters. It assessed phytoplankton species, *Escherichia coli* levels in shellfish, heavy metals, polycyclic aromatic hydrocarbons, and marine biotoxins like Diarrhetic Shellfish Poisoning (DSP), Azaspiracid Shellfish Poisoning (AZP), Paralytic Shellfish Poisoning (PSP), and Amnesic Shellfish Poisoning (ASP). Chemical contaminants present in water, biota and sediment samples monitored by DAERA under the Water Framework Directive were also evaluated. Results showed low incidents of marine biotoxins and chemical contaminants above regulatory limits, suggesting a safe environment for sustainable aquaculture and Blue Growth.

This evaluation established a starting point that reflects the present state of information from a public health standpoint. Our analysis of historical data exposed gaps in the knowledge such as the lack of monitoring of certain chemical contaminants classified under persistent organic pollutants (POPs). Nevertheless, the data gathered by environmental monitoring agencies remains valuable because it enables us to conduct point in time analysis, which may vary over time.

My PhD project aims to develop a rapid biosensor for the detection of chemical contaminants in food matrices to contribute to better-informed environmental management and public health strategies.

## Elouise Mayall

### SEARCHING FOR A BIT OF PEACE AND QUIET DESPITE UNRELIABLE CUES: DISPERSAL, SETTLEMENT AND FITNESS OF A TOP PREDATOR IN MULTI-USE FORESTS

Supervisors: Xavier Lambin, Paul Caplat, Thomas Bodey, Kenny Kortland and John Gallacher



#### Abstract

During dispersal, many organisms may gather information from their environment to judge the suitability and quality of a potential breeding territory. This information could be in the form of direct personal experiences, the presence/absence of conspecifics or their productivity in previous years. Many species have facultative protracted dispersal lasting over a year, allowing more time to gather information and reduce uncertainty. However, some individuals may also make rapid, and potentially less-informed, decisions on where to settle and reproduce.

However, the information available is not always reliable and open to misinterpretation. For example, some sites may appear attractive when visited by prospectors, but become suboptimal at later time points within the annual cycle resulting in high mortality due to disturbance of breeding attempts or persecution of adults. Such temporal ecological traps can produce maladaptive habitat selection, reducing the fitness of ill-informed dispersing individuals and creating attractive demographic sinks that reduce the growth of the entire population.

The reintroduction of the northern goshawk, *Accipiter gentilis*, has provided an opportunity to explore what factors are driving dispersal in an expanding population that heavily relies on multi-use commercial forests for breeding sites. Using a combination of GPS data from satellite tags and long-term monitoring records, I will identify key movement characteristics of goshawk dispersal, discern the types of information they are gleaned from their environment, its reliability, and how this might be influenced by changes in land use within the commercial forestry sector.

## Emily Legge

### THE EFFECT OF CHANGING SOUNDSCAPES ON TROPHIC INTERACTIONS

Supervisors: Hansjoerg Kunc, Xavier Lambin and Katy Bell



#### Abstract

Sounds in an animal's environment can be positive, neutral or negative cues. For example, they can indicate the presence of food, a non-aggressive sympatric species, or a predator. Terrestrial mammals that are exposed to sounds can change their behaviour, such as by increasing vigilance when hearing an alarm call. This behavioural change might affect how they interact with others in their environment. Therefore, the soundscape is an important information source for individuals.

The aim of my PhD is to quantify behavioural responses of terrestrial mammals to human-originating sounds (the anthrophony). Understanding how animals respond to the anthrophony, and how this response can affect their interactions with other species, will help us understand how ecosystems are adjusting to the increasing anthrophony. To achieve my aim, I am evaluating our current knowledge about the trophic interactions of terrestrial mammals, and their responses to the anthrophony, as well as collecting novel data.

To collect my data, I am conducting field experiments in habitats containing red squirrels, grey squirrels and pine martens. My aim is to test how mammals respond to the anthrophony, and to biological sounds in their natural environment (biophony). I also aim to find out whether the responses differ in habitats with different trophic communities, such as whether squirrels respond differently to the anthrophony when the pine marten predator is present in their habitat. By doing this, I aim to increase our understanding of the behaviour of the recovering red squirrel and pine marten populations, and the invasive grey squirrel population.

## Emma Cary

### USING CASE STUDIES TO EXPLORE DECISION-MAKING IN RESTORATION AND REWILDING

Supervisors: Flurina Wartmann, Xavier Lambin and Paul Caplat



#### Abstract

Rewilding is a contested term in which understandings are underpinned by values and different types of knowledge(s). The literature points to differentiated adaptations of rewilding practices in across UK contexts (Wynne-Jones et al., 2020). However, there is a lack of empirical evidence around how decisions are made in relation to different rewilding approaches, and how this feeds through to environmental and social outcomes.

Our reliance on ecosystems to deliver resilience and recovery will unavoidably result in additional pressures from competing rural land uses and interests. Given the transformative potential of large-scale land use changes brought about by rewilding, understanding which (and whose) knowledge is or is not included in the decision-making process is crucial to establishing how the benefits and disbenefits are distributed. Further, understanding the types of knowledge(s), and processes used in the design and implementation of rewilding initiatives is fundamental to determining the environmental and societal goods that they can deliver. Such considerations are central for the development of both future rewilding policy and funding mechanisms.

In this research, we take a political-ecology perspective to explore the ways in which different types of knowledge (e.g. rural, scientific, traditional) are produced and integrated in rewilding initiatives, and how this relates to decision-making in a process which is often characterised by open-endedness and uncertainty. We employ purposive sampling and an exploratory case study approach to investigate the local conditions of rewilding decision-making, using qualitative social science methodologies (participant observation, participatory mapping, focus groups, in-depth interviews) across diverse case study settings.

## Heidi McIlvenny

### SEAGRASSES IN A CHANGING CLIMATE: EXPLORING THEIR FUNCTION, HEALTH & SOCIETAL VALUE

Supervisors: Sarah Helyar, Jennifer Mckinley and David Green



#### Abstract

Seagrasses, marine flowering plants that form meadows, are significant in supporting food security, mitigating climate change, and supporting biodiversity. Although progress is being made to conserve seagrass meadows in select areas, most meadows remain under significant pressure, resulting in a decline in meadow condition and loss of function. Effective management strategies must be implemented to reverse seagrass loss and enhance their fundamental role in coastal habitats.

This thesis aims to assess the ecological and societal aspects of seagrass ecosystems (*Zostera marina* and *Zostera noltii*) in Northern Ireland, ultimately contributing to a holistic understanding of seagrass conservation and management. Four chapters comprise the experimental chapters.

- 1) A series of established ecological (e.g., percentage cover, number of shoots) and biochemical indicators (carbon, nitrogen, and phosphorus leaf content) will be assessed to investigate the condition of the *Zostera* beds, placing results in the context of local anthropogenic pressures.
- 2) The quantity (i.e., total organic carbon) and quality (i.e., chemical recalcitrance) of seagrass sediment carbon will be evaluated, and the factors influencing the carbon pool will be examined.
- 3) Next Generation Sequencing (NGS) approaches (e.g., ddRAD-sequencing to generate SNPs) will be used to assess spatial patterns of genomic diversity, population divergence and connectivity in *Z. noltii* across Ireland.
- 4) To explore the human dimensions of seagrasses a public perceptions survey aiming to understand how the general population understands, values, and engages with seagrass beds in Northern Ireland will be conducted.

## Jacinta Guirguis

### EXTINCTIONS OF BIODIVERSITY BY DAY AND NIGHT

Supervisors: Daniel Pincheira-Donoso, David Fisher and Neil Reid



#### Abstract

Humans are causing the annihilation of biodiversity worldwide. In addition to species extinctions, population declines cause loss of ecosystem function, resulting in changes to macroecological patterns already being observed. Yet, the pressures exerted onto species, as well as species traits that may predispose them to extinction, are not evenly distributed along the diel (or 24-hour) cycle, leading to the hypothesis that extinction risk may be associated with the a species' diel niche.

However, the mechanistic theories underlying why diel niche may be associated with extinction risk predict opposing trends or may only apply to certain taxonomic groups. For instance, diurnal activities of humans may interfere with fitness-related activities of diurnal species, whilst nocturnal climate niches are thought to be warming at greater rates. Thus, a generalisation of the effect of diel niche on risk of extinction is missing from our collective knowledge.

Using global-scale datasets for amphibians, lizards, birds and mammals, I performed Bayesian phylogenetic regressions to test whether a species' diel niche is associated with their risk of extinction, using two proxies of extinction risk.

## James Dill-Russell

### MULTI-PROXY INVESTIGATION OF THE IMPACT OF A DRIER CLIMATE AND HUMAN IMPACT ON PEATLAND SYSTEM RESPONSES AT SLUGGAN MOSS A RAISED BOG IN COUNTY ANTRIM, NORTHERN IRELAND

Supervisors: Gill Plunkett, Graeme Swindles and Jo Smith



#### Abstract

Due to their dependency on precipitation for nutrients and water, ombrotrophic peatlands are sensitive to climate change, and therefore represent important archives of past climate fluctuations. While many peatland-derived palaeoclimate studies have reconstructed wet/cold intervals, there has been less focus on how ombrotrophic peatlands respond to climate change, particularly to warmer/drier conditions. Peatland system responses to drier conditions are of particular interest because carbon emissions from peatlands are expected to increase as the Earth continues to warm, creating a positive feedback.

Here we consider the period between 6000–5000 BP when one or more episodes of drying in the UK and Ireland have been suggested by previous peatland studies. Drawing on a record from Sluggan Moss, Northern Ireland, we undertake a multi-proxy reconstruction of peatland hydrology and vegetation to investigate the nature and timing of climate impacts on the peatlands at this time, and their effects on carbon accumulation.

We differentiate the role of anthropogenic impacts on the regional water table with the aid of pollen analysis, allowing us to tease out the drivers of peatland system change. By testing the replicability of our findings within and between bogs, we hope to provide a better understanding of peatland responses to future climate change scenarios.



## Kyle Lowry

### FROM ROCK TO RESOURCE: ARCHAEL-MEDIATED PHOSPHORUS SOLUBILISATION

Supervisors: Chris Allen, Cécile Gubry-Rangin and Julianne Megaw



#### Abstract

More than 90% of phosphorus in soil is essentially inaccessible as it exists in insoluble forms, especially various insoluble phosphates of calcium, iron, and aluminium. If this insoluble phosphorus could be made available to plants, it would mobilise a vast phosphorus supply without the ecological risks while reducing reliance on commercial fertilizers.

Microorganisms are fundamental to all ecological systems due to their central role in biogeochemical cycling of essential nutrients including carbon, nitrogen, and phosphorus. Phosphate-solubilising microorganisms are those that are capable of solubilising variably insoluble phosphate molecules such as calcium, iron and aluminium phosphates. However there has been little investigation into the utilisation of recalcitrant phosphate sources. Methylophilic bacteria capable of utilising highly novel phosphates have recently been identified, but this has yet to be demonstrated in the other prokaryotic domain *Archaea*.

The focus of this research project will therefore be to investigate the utilisation of certain novel phosphates in *Archaea*. Isolation of archaeal species from Northern Irish soils capable of utilising these phosphates. Genetic and biochemical characterisation of the isolates to investigate the potential mechanisms of phosphate solubilisation and utilisation. Investigation of methylophilicity in archaea in Northern Irish agricultural soils. Characterise relationships between archaeal populations in Northern Irish agricultural soils with agricultural fertilisation practices and physiochemical data.

## Leia Kristen Tilley

### 'NORTHWARD WANDERINGS' – UNCOVERING THE LATE GLACIAL PALAEOENVIRONMENTS OF SCOTLAND AND IRELAND AND THE RELATION OF EARLY HUMAN COMMUNITIES TO THESE

Supervisors: Kate Britton, Maarten Blaauw and Matteo Spagnolo



#### Abstract

There is a rich tradition of palaeoenvironmental research for Scotland and Ireland, with a significant collective of data generated relating to the environments of these regions post-the Last Glacial Maximum (23,000-19,000 cal BP). Archaeological datasets, in comparison, have, until recently, been limited. This factor, combined with the misidentification of assemblages now known to be of Late Upper Palaeolithic date, might, in part, be a consequence of an enduring narrative of an inhospitable Scotland and Ireland not conducive to any form of permanent, long-term human engagement, despite many Late Glacial pollen datasets demonstrating diverse plant communities potentially foundational to complex hospitable environments for recolonising human groups.

These datasets require re-examination within the context of a now-accepted human presence in Late Glacial Scotland and Ireland to build a more interrogative knowledge of early human communities. In order to more clearly understand Late Glacial environments and the potential for plant-focused resources encountered by recolonising human communities, existing palaeoenvironmental datasets need to be effectively integrated into the archaeological corpus. However, much of the extant pollen and non-pollen palynomorph (NPP) data has previously only been considered in isolation or is in a 'legacy' state with all the associated issues of variant reporting qualities, inaccuracies, etc.

The beginnings of this process of re-examination and integration are explored here in parallel to the challenges in working with these data strands. These are early observations but already demonstrate the environmental diversity and resource availability open to early human communities.

## Louise Anne Smith

### EXPLORING THE EFFECTS OF POST-MEDIVAL CROFTING ON THE MODERN HILLSIDE ECOSYSTEM

Supervisors: Jeff Oliver, Gill Plunket and Kate Britton



#### Abstract

Agricultural practices have been shown to have strong and lasting impacts on biodiversity and the effects of current agriculture on plant biodiversity have been well studied. Modern agricultural practices in Scotland originated during the period of improvement starting in the 18th and the early 19th century. During this period farm layout changed towards larger-scale capitalist operations, leading to the consolidation of common fields and smaller tenancies and the displacement of many farmers. Some displaced farmers became crofters settling on more marginal, less desirable land mostly in the uplands. This led to a more intense management of the uplands than in previous centuries. Crofters transformed the landscape, soil, and vegetation to allow them to undertake small-scale arable farming and pastoralism. Today many of the former crofting sites have been abandoned and lie fallow. However, the effect of crofter colonists can still be seen today in the patterns of standing archaeology and vegetation ecology.

The project aims to combine the use of traditional environmental archaeological and ecological methods to investigate the long-term effects of upland crofting on modern vegetation ecology and biodiversity. The data will originate from an analysis of historical biodiversity via a palynological investigation and the current biodiversity via plant surveys and species analysis. The combination of these approaches will produce a unique interdisciplinary method that will enable us to understand the impact of post-medieval settlement on the plant biodiversity of upland areas.

## Mhairi Hallford

### TESTING THE VERACITY OF SATELLITE-DERIVED END OF SEASON SNOWLINE ALTITUDES AS A PROXY FOR THE GLACIER ELA: PRELIMINARY RESULTS

Supervisors: Brice R. Rea, Donal Mullan, Matteo Spagnolo,  
Lydia Sam and Shaktiman Singh



#### Abstract

Extensive databases of satellite imagery are now available and can be used to undertake assessments of the mass balance of glaciers. Previous studies have mapped the end-of-season snowlines (ESS) on glaciers from satellite imagery to find their snowline altitudes (SLA) and used these as proxies for the glacier equilibrium-line altitudes (ELA). This approach is advantageous because it can be implemented at scale and may employ automated methods. The veracity of using remotely measured SLAs as a proxy for in-situ measured ELAs however, has not yet been robustly demonstrated.

This project is undertaking a systematic mapping of ESSs on glaciers with existing measured mass balance records to determine the errors associated with remotely measured SLAs. Glaciers are selected from the World Glacier Monitoring Service (WGMS) Fluctuations of Glacier (FoG) database. For each ELA record, we identify the Landsat image closest in date to the original ELA measurement (where cloud cover is minimal) and the image with the highest altitude snowline for the year. For each image, the snowline is mapped, and its corresponding SLA is extracted from the ASTER Global Digital Elevation Map (ASTERGDEM). The SLAs vs. ELAs of 6 glaciers covering time series of 14 to 34 years are presented.

## Naomi Rich

### ENVIRONMENTAL DRIVERS OF PARENTAL CARE DIVERSITY IN MAMMALS

Supervisors: Lesley T. Lancaster, Domhnall J. Jennings, Greta Bocedi and Isabella Capellini



#### Abstract

Parental care - defined as any parental trait that enhances the fitness of offspring, frequently comes at a cost to future reproduction and survival, thus it should only evolve when the benefits to carers outweigh the costs. Environmental conditions should play an important role in parental care evolution as they modulate pressures like resource availability and predation risk, thus influencing the costs and benefits of care.

Care is more likely to evolve under intense resource competition and when environmental conditions are harsh, as under these conditions the benefits of care are likely to increase. In mammals, male care has evolved numerous times and occurs in ~10% of species, but the environmental drivers of male care are poorly understood. Mammals that have allocare – care from non-breeding helpers (i.e. cooperative breeding) – live in arid environments with less rainfall than socially monogamous species lacking allocare.

Here we ask whether male care also evolved in similar environments and is the driver for the evolution of allocare. We address this question while considering also female-only care as well as biparental care and allocare and uncover the specific environmental drivers causing diversity in who cares in mammals. We conducted a phylogenetic comparative study on >500 mammal species to test the associations between care provider, care traits and environmental conditions within the species range.

## Rachael Kelday Clark

### ENVIRONMENTALLY TRANSMITTED PATHOGENS IN WILD RED AND ROE DEER: THE ROLE OF LAND USE AND BIOCLIMATE

Supervisors: Mark Moseley, Kath Allan, Eric Morgan and Sandra Telfer



#### Abstract

Wildlife can play an important role in the epidemiology of important pathogens of livestock and humans by acting as reservoirs or vectors for infection. Leptospirosis and Johne's disease are caused by bacteria that are environmentally transmitted. These diseases are important diseases of livestock that are routinely controlled on farms as part of the Premium Cattle Health Scheme. The presence of wildlife can complicate disease management as control measures, such as vaccination, are challenging in wildlife species.

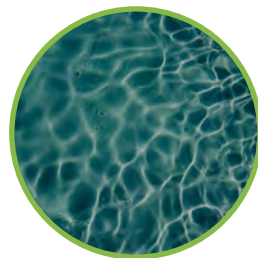
Using wild deer as sentinels, we aim to use serological and molecular approaches to explore the environmental variables that facilitate survival and transmission of environmentally transmitted pathogens. Serum samples were sent for serological testing to explore if deer have been exposed to livestock pathogens. DNA was extracted from faecal samples and PCRs were used to detect the presence of mycobacterial species, using the *ku* gene, a biomarker for non-tuberculosis mycobacteria.

Preliminary phylogenetic results have revealed a diversity of novel mycobacteria in wild deer, with distinct spatial structuring, although this spatial structure breaks down in red stags and one red hind, suggesting that red deer, particularly stags, are moving larger distances to new areas and carrying novel *Mycobacteria* species with them, which could have implications for livestock in these areas. Future work will include expanding sampling across different habitats including areas of higher elevation, sampling additional tissues to widen pathogen screening, and testing livestock samples in the same area to identify if there is transmission or a common source of exposure between livestock and deer.

## Sodiq Solagbade Oguntade

### THE IMPACT OF SUBSURFACE HETEROGENEITY ON THE PERFORMANCE OF AQUIFER THERMAL ENERGY STORAGE (ATES) SYSTEMS

Supervisors: Ulrich Offerdinger and Jean-Christophe Comte



#### Abstract

Energy demand continues to rise globally with the largest percentage being met by fossil fuels which emit greenhouse gases and drive climate change. Significant efforts have been made in decarbonising the energy demand, especially power generation and transportation. However, less progress has been made in the heating and cooling sector, in parts due to seasonal mismatch between energy demand and supply. Aquifer thermal energy storage (ATES) system- an efficient form of thermal energy storage, provides a solution to this challenge.

The performance of an ATES system is affected by subsurface heterogeneities (depositional features of sedimentary aquifers, fractures, igneous intrusions etc.) and this study will focus on the Triassic Sherwood Sandstone Aquifer to investigate the impacts of these heterogeneities.

This study will utilise borehole nuclear magnetic resonance, borehole geophysics and pumping tests for baseline characterisation of the aquifer system. Also, short and long-term monitoring of thermal injection tests at different temperatures will provide insights into the thermal properties of the aquifer. Numerical heat transport models will be developed using the monitored data to evaluate different application scenarios for ATES systems.

This research outcome will serve as a reference for the extent of subsurface heterogeneities on the performance of ATES systems.

## Tegan Gaetano

### IMPORTANCE AND SUSTAINABILITY OF ENDANGERED COMMUNITIES OF BEE POLLINATORS IN THE MACHAIR, A CHANGING COASTAL ECOSYSTEM

Supervisors: Fabio Manfredini, Lesley Lancaster, Paul Williams, Robin Pakeman and Richard Comont



#### Abstract

One of the rarest habitat types in Europe, machair is a biodiverse ecosystem mosaic of dunes, wildflower-rich grasslands, and rotationally cultivated fields unique to the north- and west-facing soft coasts of Scotland and the Republic of Ireland. Machair habitats uniquely support several species of endangered insect pollinator including the great yellow bumblebee (*Bombus distinguendus*). Once found throughout Great Britain, this species is now restricted to the machair of northwest Scotland and its islands.

Effective species management planning for this and other species of nationally endangered bee requires a complete understanding of both the characteristics of this habitat that encourage healthy plant-pollinator systems and threats to its continued ability to support them. Investigations into the characteristics of machair habitats that make them suitable for bumblebees and other insect pollinators have primarily focused on food plant abundance and diversity. Few studies have explored the underlying nutritional landscape of machair flowering plants.

This research will characterise the role of micronutrients, particularly sodium, in facilitating the plant-pollinator networks of machair habitats of five of Scotland's islands. Moreover, while partly a product of human management, climate change and land use intensification have led to significant loss of this flower-rich habitat, further endangering its rare insect pollinators. This work will incorporate data on the nutritional profiles of machair flowering plants and habitats into climate projection models to investigate current and potential future impacts of human-driven environmental changes on the composition and distribution of machair floral resources and the populations of bees that depend on them.



## Xavier Richard Badham

### ECOLOGICAL STABILITY OF A RIVER COMMUNITY ALONG A GRADIENT OF NUTRIENT STRESS

Supervisors: Lesley Lancaster, Sarah Helyar and Mark Emmerson



#### Abstract

Excess nutrients, including nitrates, phosphates, and ammonia, can lead to harmful algal blooms and can disrupt animal metabolic processes stressing individuals, populations, and communities. These stressors may in turn affect ecological stability and ecosystem responses to disturbance. Here we investigate the link between ecological stability and nutrient concentration.

We use the Upper Bann River, in Northern Ireland, as a study area exhibiting a gradient of nutrient stress reflecting increasing agricultural land use downstream. We quantify community dynamics through invertebrate and algal trophic interactions, abundance, and biomass. Experimental disturbance of the streambed provides insight into stability, quantified through recovery, resistance, and variability metrics. Food web properties derived from a mixture of literature review and gut contents meta-barcoding analysis are explored.

Initial findings highlight distinct community variations along the Upper Bann defying typical River Continuum Concept classifications. Unconventional community patterns suggest that ecosystem stability and functioning may be altered via experimental disturbance.

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