Ecosystems and Landuse Policy Group (ELPEG) Bulletin – May 2025

Introduction

Welcome to this, our seventh ELPEG bulletin of the 2022-2027 RESAS Strategic Research Programme. The aim of this bulletin is to provide policy makers with updates on the research on biodiversity that is happening within the strategic research programme. The bulletin covers work from Topic D4 (Biodiversity) and the biodiversity elements within the air pollution Topic (D1).

Following the positive comments received on our revised format for the October 24 bulletin we have continued with the same format. Each project has a one page summary that highlights the relevance of the project to current policy. This includes a list of key words, which we hope will enable you to quickly identify projects of relevance to your work. This is followed by a second page providing more detail on the project, its objectives and methods.

We welcome your feedback on this bulletin and if you have comments please do either provide them at the ELPEG meeting or contact Ruth.Mitchell@hutton.ac.uk

Contents

Nitrogen impacts in natural ecosystems

Lead PI: **Andrea Britton** (andrea.britton@hutton.ac.uk)

Overall project aim:

To improve understanding of the impacts of nitrogen deposition on Scottish natural ecosystems in the context of a changing climate, providing evidence on how natural ecosystems are changing, what is driving this change and how best to manage and protect them

Key policy topics:

Air quality, Cleaner Air for Scotland Strategy, Climate change, Biodiversity, Soils

Policy relevance:

- This project contributes to the objectives of the Cleaner Air for Scotland 2 (CAFS2) Strategy by providing information on atmospheric nitrogen impacts on biodiversity and the environment in Scotland and by exploring new monitoring methods and indicators for nitrogen impacts and recovery.
- The project also provides data on above and belowground biodiversity in upland and forest habitats which can be used to inform protected area development.
- Information feeds into policy development at multiple levels with contributions to the Scottish CAFS2 Agriculture and Environment Working Group, UK-wide JNCC led APRI project to develop nitrogen recovery indicators and to the development of European Nitrogen Critical Loads through the UN-CLRTAP Coordinating Centre for Effects.

Recent highlights and outputs:

- Website: Nitrogen deposition impacts in natural ecosystems | SEFARI

Outputs:

- Nitrogen and climate: a review of the interactive effects of nitrogen deposition and climate change on Scottish semi-natural vegetation.
- Nitrogen mitigation: a review of nitrogen deposition impacts and mitigation potential in Scottish semi-natural ecosystems.

Nitrogen impacts in natural ecosystems

Specific objectives and summary of recent work

1. **Nitrogen and climate impacts on above and below ground biodiversity in alpine ecosystems**
   Contact: andrea.britton@hutton.ac.uk
   We are revisiting long term vegetation plots for a third time in 50 years, to examine how nitrogen and climate change are affecting plant and soil biodiversity in alpine habitats. So far, we have resurveyed vegetation and sampled soils and moss at 198 locations across Scotland. During summer 2025 we will complete the field survey with an additional 100 plots across Orkney, Shetland and the Cairngorms. DNA has been extracted from all soil samples collected to date and sequenced to allow analysis of soil biodiversity patterns in relation to pollution and climate drivers. Chemical analysis of moss and soil will be used to assess local variation in nitrogen deposition relative to modelled data. First impressions from survey visits suggest that alpine plant communities have changed significantly over the last 20 years.

2. **Nitrogen and climate impacts on woodland ectomycorrhizal communities**
   Contact: andy.taylor@hutton.ac.uk
   We have been collating data on fungal communities from public databases and generating new DNA-based field survey data to investigate how nitrogen deposition and climate influence fungal communities associated with birch, oak and pine woodlands. In total, our studies in 2022-2024 have generated new data from 54 semi-natural woodland sites from across Scotland. These data have greatly expanded our understanding of fungal and broader soil biodiversity in Scottish woodland soils. During 2024 we also partnered with Forestry and Land Scotland to extend this study to include plantation forests of Scots pine and Sitka spruce. Field data collection is now complete, and the dataset is being analysed to assess how woodland soil communities are influenced by climate and nitrogen deposition and to determine if we can identify thresholds and indicators for adverse impacts on biodiversity and ecosystem functioning.

3. **Impacts of nitrogen climate interactions on ecosystem function**
   Contact: andrea.britton@hutton.ac.uk
   Using long-term (20+ years) experimental plots in alpine heath we have continued to investigate how warming, nitrogen additions, burning and their interactions affect biogeochemistry and above and belowground biodiversity. A scientific paper has been submitted which demonstrates the long-lasting impacts of nitrogen and burning on soil biodiversity 12 and 22 years after treatments ended, and the increasing effects of warming. The results of this study are informing on the best metrics for monitoring ecosystem recovery from nitrogen deposition, and we have continued to work with JNCC and UKCEH using this unique long-term experiment as a case study to test recovery indicators. Additionally, we have been running new lab-based experiments to test interactive nitrogen-warming effects on upland mosses. This study will help to unpick the mechanisms behind the vegetation changes that we have observed during the alpine resurveys.

4. **Modelling of nitrogen climate interactions**
   Contact: mike.rivington@hutton.ac.uk
   This project is starting in 2025 and will use data gained from all studies to model risks to Scottish ecosystems from interactive impacts of nitrogen deposition and climate change.

5. **Experimental trial of nitrogen mitigation methods and indicators**
   Contact: robin.pakeman@hutton.ac.uk
   We are examining the potential benefits of restoration in mitigating the impacts of nitrogen deposition on peatlands. We have identified pairs of restored and unrestored sites along a nitrogen deposition gradient within Scotland and sampled vegetation and soils to assess total nitrogen contents and element ratios which are useful indicators of nitrogen impacts. Six pairs of sites were sampled in 2024, and in 2025 sampling will be extended to Cumbria to include heavily nitrogen-polluted sites and aid interpretation of the data.

People and Nature

Lead PI: **Katherine (Kate) Irvine** (kate.irvine@hutton.ac.uk)

Overall project aim:

Identify and evaluate interventions, approaches and processes to facilitate the transformative change of how Scotland's biodiversity is framed, valued, managed and governed, and how to harness and more equitably distribute the associated benefits.

Key policy topics:

Scottish Biodiversity Strategy, Protected areas, Green infrastructure, Wellbeing economy, Agriculture

Policy relevance:

- This project specifically considers indirect drivers such as ways of thinking and behaviour, with relevance for a range of policies. For example, findings can inform the development of delivery plan actions that are participatory, inclusive and enable 'whole of society' engagement.
- The work on tools to enable cross boundary collaboration between land workers for ecosystem health and landscape scale impact supports continued investment in peer learning initiatives in agricultural policy.

Recent highlights and outputs:

- Website: https://sefari.scot/research/projects/people-and-nature
- Biodiversity narratives multimedia digital platform prototype. David Donnelly, Katrina Brown & Alba Juarez Bourke. (2025). https://restoryation.hutton.ac.uk/
- The potential of clustered farming groups to foster transformative change: A qualitative case study. Ishaan Patil, Sarah Pohlschneider & Katherine Irvine (2025). Research report. (available upon request)

People and Nature

Specific objectives and summary of recent work

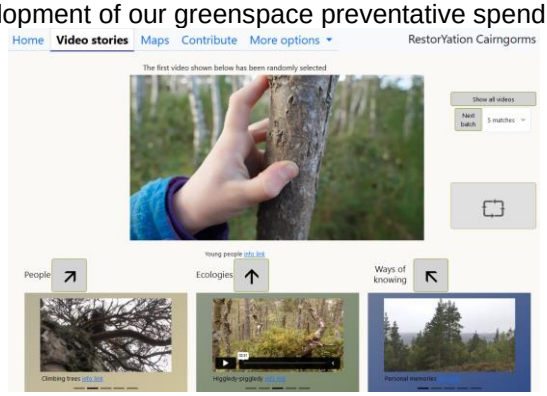
1. **Nature and Economy: Exploring nature-economy relations and the implications of different framings for managing nature.**
   We completed data collection for our second phase of research exploring nature-economy relationships in Scotland for which we focused on communities (year 3). This field-based study built on our literature review (year 1), and our field-base Q study of civil sector workers across Scottish Government bodies and institutes to identify the different understandings of nature-economy relations which play out in everyday policy implementation practice (year 2). For this second phase, we held workshops with several disadvantaged communities to vision alternative nature-economy relationships in Scotland. The workshops used an innovative game-based method, developed by the researchers, to facilitate deliberation and dialogue on what an economy embedded in nature might look like. Analysis is under way; findings will be combined with phase one results to inform a final deliberative workshop (year 4).

2. **Enabling inclusivity in biodiversity narratives: Developing a digital platform and approach to integrate diverse perspectives into co-generated place-based biodiversity management.**
   We further developed the prototype digital platform and approaches to foster inclusion of diverse perspectives into biodiversity management. Through our stakeholder engagement and co-creation process, we obtained input from experts across multiple sectors and research disciplines on the platform's usability and interface. This informed iterative platform modifications to facilitate ease of navigation through the interwoven material of maps and experiential video stories which illustrate the three axes of marginalization: people (e.g. gender); ecologies (e.g. particular habitat); and ways of knowing (e.g. Gaelic). Alongside, we further identified, developed, and explored the feasibility of different techniques for gathering and inviting response to stories. The platform now, for example, includes a created map layer of gender-related stories and Gaelic place names. Feedback obtained will inform a final round of field-testing the platform (year 4).

3. **Transformative biodiversity research and change: Identifying interventions to support cross boundary collaboration for biodiversity impact in agricultural landscapes.**
   This research strand has finished. A final report is available upon request while we await DOI and weblink. Our case study explored 'facilitated collaboration' as a type of intervention to foster change in agricultural practice. Findings suggest that collaborations that are facilitated by experienced individuals support peer learning about alternative practices. The social learning space that is generated through these types of interventions enables transformative change in knowledge, identify, and practice to begin and to flourish.

4. **Values: Examining approaches to foster shifts in relationship with and values held about nature.**
   We completed data collection for our mixed method study of Forest Therapy as a potential intervention to support change in nature relationships and values. This small-scale feasibility and acceptability study is being conducted in collaboration with the RESAS project titled 'Reciprocal Care for Nature and Wellbeing' (JHI-C6-1) which focuses on identification of mechanisms to support use of nature for wellbeing. Recruitment generated 60 enquires from women 40+ years old (our study population); 28 individuals enrolled, 24 completed the full 6-week study. We additionally commenced an examination of literature to understand the characteristics of the environments in which these nature-based programmes take place.

5. **Green/ blue infrastructure for people and nature: Assessing the role urban nature plays.** For our urban nature and quality of life case study, we implemented the stakeholder-informed final questionnaire during autumn 2024. Over 180 individuals took part (adult residents of the case study area), the majority completing the online survey complemented by several structured interviews. Preliminary insights from open-ended questionnaire responses were shared with local stakeholders and a year 4 plan for analysis refined. Overall, this study examines the effectiveness of quality of urban life assessments as a tool for capturing negative and positive impacts of changes in the quality and availability of green space in urban settings. We additionally commenced development of our greenspace preventative spend literature review.



Identifying the causes of biodiversity change with specific references to the IPBES drivers

Lead PI: **Robin Pakeman** (robin.pakeman@hutton.ac.uk)

Overall project aim:

The aim of this project is to identify how the "IPBES drivers", specifically climate change, land use change, pollution and invasive species, affect key parts of Scotland's biodiversity.

Key policy topics:

Climate change, Farm clusters, Land use strategy, INNIS, Pollution

Policy relevance:

- Addresses the actions under the Priority Action "Implement Scottish Plan for INNS Surveillance, Prevention and Control" through widening understanding of INNS in previously under-studied (as far as INNS are concerned) environments
- Feeds into the action "Scale delivery of the Peatland Action programme, restoring the condition of peatlands as a key ecosystem in line with Net Zero targets and supporting the expansion and upskilling of the peatland restoration workforce" as INNS threaten peatland restoration.
- Interacts with agricultural reform policy and land use strategy
- Working with Scottish Government over farm clusters
- Contributing to the revised Scottish Plant health Strategy

Recent highlights and outputs:

- Pakeman, R.J., Bienkowski, D., Fielding, D.A., Thiel, A. and Evans, D.M., 2025. Assessing the impacts of livestock grazing on upland bird breeding territories using drone surveys. Journal of Avian Biology, 2025, e03356. https://doi.org/10.1111/jav.03356

Identifying the causes of biodiversity change with specific references to the IPBES drivers

Specific objectives and summary of recent work

1. **Global change impacts on sustainable upland land use** Contact: robin.pakeman@hutton.ac.uk
   Meadow pipit territory sizes are correlated to vegetation biomass (assessed using drone-based remote sensing) as they are larger where there are more tussock forming grasses. The long-lived nature of these tussocks likely constrains the effects of grazing treatment on nesting density. Analysis of insect body composition indicates some impact on diet quality in the different treatments. In particular, flies have higher nitrogen contents in the more heavily grazed treatment.
2. **Collective landscape management of farmland biodiversity** Contact: graham.begg@hutton.ac.uk
   With our support, the Buchan Farm Cluster has continued with the introduction of new bird and pollinator seed mixes and made other habitat improvements. In 2024, a comprehensive programme of biodiversity monitoring was completed, following up on previous surveys in 2022 and 2023. Over this time, an increase in species diversity of 12% has been recorded, with the Corn bunting, a target species of the cluster, expanding into new areas of the farmer cluster.
3. **Using long-term aphid monitoring data to assess drivers of biodiversity change** Contact: ali.karley@hutton.ac.uk
   The statistical analysis of flying aphid data since the 1960s from three suction traps (Dundee, Edinburgh, Ayr) has shown a shift in aphid taxonomic composition and diversity in the past ~2 decades which correlates with increased temperatures and changes in specific land uses. The analyses are being extended to assess the impacts of winter temperatures on the timing of aphid arrival in spring and carry-over effects of aphid abundance from one year to the next. Results have been presented to agriculture stakeholders at different industry engagement events.
4. **Using Scotland's Caledonian forest as a model system to assess impacts of major climate drivers** Contact: alison.hester@hutton.ac.uk, jenni.sockan@hutton.ac.uk
   Our "future drought scenarios" experiment on native Scots pine saplings has just completed the third year of experimental drought treatments. We are continuing to monitor bud burst bud, growth and survival of young pines in each treatment group. Evidence of both immediate and delayed responses are emerging from the different treatments, and further analysis will take place this winter.
5. **Assessing potential effect of chemical pollution on the wild Scottish salmon** Contact: zulin.zhang@hutton.ac.uk
   Two years monitoring works were conducted for chemical contaminants in water and salmon from the River Dee. It was found that the endocrine disrupting compounds were present in both river water and salmon samples. This would continue to carry on into the next year (totally 3 years continuous monitoring campaign) and it would be interesting to see the trend and interaction of contamination between the river water and fish.
6. **Improved technology to track invasive non-native pathogens and their effects on ecosystems** Contact: david.cooke@hutton.ac.uk
   Amplification of the new broad oomycete marker and corresponding synthetic barcode controls has been completed. Existing sequence and meta-data back to 2018 will be uploaded to the European Nucleotide Archive in line with Open Science objectives.
7. **Impact Assessment of Invasive Non-Native Species** Contact: michaela.roberts@hutton.ac.uk; ruth.mitchell@hutton.ac.uk Building on interviews carried out in August and September we carried out a workshop with representatives from a range of conservation and land management organisations. Overall INNS burden was perceived to be low, although Sitka spruce and rhododendron were controlled by most. No control of invasive pests or pathogens were identified, though control of native pests such as heather beetle and ticks were recognised as being potential options for future control.

Scotland's Biodiversity: People, Data, Monitoring

Lead PI: **Jenni Stockan** (jenni.stockan@hutton.ac.uk)

Overall project aim:

To help protect Scotland's share of global biodiversity by optimising people's skills, data, and technologies to ensure effective recording and monitoring techniques and data flows.

Key policy topics:

Protected areas, 30 x 30, Scottish Biodiversity Strategy, Agricultural reform, Drivers of change

Policy relevance:

- The work on Improved Reporting of Biodiversity could feed directly into monitoring and evaluation of the SBS and where to focus action on drivers of change.
- The Bio4Ag Toolbox has been co-developed with NatureScot POBAS & Biodiversity Audit teams, LEAF Innovation Centres and LTER agroecology expert group to facilitate transition to biodiversity-based cropping systems.
- The work on alpine soil biodiversity is providing evidence on the suitability of new techniques (Citizen science, eDNA) for biodiversity monitoring. The data will also contribute to Air Quality and Biodiversity policy by contributing evidence on nitrogen deposition impacts on biodiversity.

Recent highlights and outputs:

- Walton, P et al. (2023) State of Nature Scotland 2023. The State of Nature Partnership. https://stateofnature.org.uk/wp-content/uploads/2023/09/TP26056-SoN-Scotland-summary-report-v5-1.pdf.pagespeed.ce.EIp-TYaoGQ.pdf

Scotland's Biodiversity: People, Data, Monitoring

Specific objectives and summary of recent work

1. **Creating a Scottish biodiversity inventory** Contact: andy.taylor@hutton.ac.uk
   We are compiling data on the extant taxa in Scotland using post 1950 data and their taxonomic backbone from the NBN Atlas as the basis for records. Comparisons with the 1997 last full inventory of Scottish biodiversity are continuing, but there is still a large discrepancy between this past estimate and current taxon richness. Verification of records (identification, locality, date) is proving challenging for some taxon groups. Specialist datasets and publications (in particular for insects and nematods) are being mined for additional species records.

2. **Improved reporting** Contact: robin.pakeman@hutton.ac.uk
   The paper assessing the impact of different weighting methods to allocate species trends to habitats to derive habitat level trends is still in review. With State of Nature partners we are putting together a data paper to publish some of the trend data from State of Nature. This will create an accessible record of trend information that could be further analysed by the scientific community.

3. **Oceanic-alpine soil biodiversity** Contact: andrea.britton@hutton.ac.uk
   The Mountain Heights, Hidden Depths citizen science project is exploring and mapping alpine soil biodiversity across Scotland's Munros, supported by over 400 volunteer hill walkers. During the summers of 2021-2024 samples were collected from alpine grassland, dwarf-shrub heath and moss heaths across Scotland's Munros. Thanks to our volunteers' fantastic efforts, a total of 765 samples were collected from 255 out of 270 Munro summits covering the length and breadth of Scotland's alpine zone. DNA has been extracted and sequenced from all the samples, and we are now working with the data to identify the DNA sequences and determine the biodiversity present in these soils. The success of this project has demonstrated that combining citizen science and eDNA based approaches and working with the 'community of place' can be an extremely successful way to generate biodiversity data for remote and challenging habitats. This dataset is globally unique in its scale and biodiversity coverage. As we move into the data analysis phase, we will reveal the richness of the biodiversity associated with Scotland's mountain soils, and our analyses will investigate how the composition of soil communities responds to factors including rainfall, temperature, elevation, geology and nitrogen deposition. We will also be exploring how best to disseminate our findings to our volunteer network and our stakeholders.

4. **Monitoring approaches for outcomes focused interventions** Contact: cathy.hawes@hutton.ac.uk
   Data on biodiversity and soil health indicators over the past 12 years from the Centre for Sustainable Cropping long-term experiment have been analysed alongside crop yield and carbon footprint calculations to provide a baseline for impact assessment in commercial arable farms. Findings from the CSC will be presented as a series of technical notes describing the effects of integrated management on each, the potential long-term costs and benefits and a method for monitoring that can be applied by non-experts on their own farms. This material will form part of the new Bio4Ag toolbox (an open access, online, interactive resource library) designed to facilitate the transition towards biodiversity-based cropping systems, guiding users through the iterative process of cropping system design, implementation and monitoring for enhanced biodiversity and soil health.

Habitat management and restoration

Lead PI: **Andy Taylor** (Andy.Taylor@Hutton.ac.uk)

Overall project aim:

To gain biodiversity in moorland and woodland habitats through evidence-based land management and restoration to maximise benefits to society.

Key policy topics:

Accelerating restoration and regeneration, Protected areas, 30 x 30, Invest in Nature, Support thriving communities, Protect vulnerable and important species and habitats

Policy relevance:

- This project is currently generating new evidence to support the development and implementation of policy relating to moorland management guidelines using muirburn or alternatives as tools for heathland management; restoration of Atlantic oak rainforest sites from former commercial plantations, and mapping the flows of social, economic and ecological benefits from woodland creation projects.

- Project findings and expertise are feeding into other national rainforest restoration and regeneration programmes from conservation groups, including The Alliance for Scotland's Rainforest, Argyll and the Isles Coast and Countryside Trust (ACT), The Woodland Trust, and FLS.

Photo Credit: Anna Conniff, The James Hutton Institute

Recent highlights and outputs:

- Atlantic oak woodland functional biodiversity and restoration of PAWS | SEFARI
- BBC Radio Scotland Out of Doors 26th April 2025 https://www.bbc.co.uk/sounds/play/m002bgk4
- Provided summary of findings in advance of Wildfire Management and Muirburn Bill debate

Habitat management and restoration

Work packages and summary of recent work

1. **WP1. How can public and private sector investors, at low risk, restore woodland habitats for the most multiple benefits to society in addition to increasing natural carbon capture and biodiversity, and what land is available for this?** Contact: matt.hare@hutton.ac.uk

   The restoration and expansion of woodland habitats are integral to combating climate and biodiversity crises, and this project focuses on how we can assess and maximise equitable flows of benefits from past and future woodland schemes across rural and urban Scotland. As part of our work in developing a coupled biophysical and agent-based model of woodland benefit flows, we have modelled carbon sequestration at a national scale from woodland created under the Forestry Grant Scheme (1991 – 2022), including both carbon gain by the trees and net soil carbon loss due to forestry operations. Our research on benefit flows from urban woodland creation has focused on the 'Woodlands In and Around Towns' (WIAT) initiative and historical planting carried out in Craigmillar Castle Park, Edinburgh. Fieldwork to gather evidence of benefits flows has involved an online survey, interviews and a public touch-table event, to elicit the opinions of local residents, businesses and voluntary groups. Initial findings from this fieldwork have provided insights about the changing temporal flows of benefits, and the diversity of economic activities, in and around the park over the years, that might be relevant to deliberations on the next phase of the WIAT programme.

2. **What is the impact of Muirburn on nature and how does this impact compare to mechanical removal of vegetation?** Contact: stuart.smith@hutton.ac.uk

   This project investigates the relationships between the use of Muirburn for regenerating ericaceous and grassland heathlands and wildfire risk, biodiversity, and ecosystem functioning. Relationships between the geographic overlap in areas subject to Muirburn and wildfire were addressed in a paper in Biological Conservation, which highlighted that overlap was limited, though the reasons for this need to be explored further. This work was also presented at the UK Wildfire conference in Aberdeen in November 2023 and covered on BBC Radio Scotland Out of Doors in April 2025. Fieldwork focuses on comparing Muirburn with alternative mechanical approaches in two field experiments at JHIs upland farm at Glensaugh and in collaboration with the RSPB at Abernethy. These studies found that brush cutting resulted the lowest impact on carbon loss and plant litter carbon losses compared to muirburn and robocutting, while analyses of soil nutrients and C cycling found little difference among treatments. Increases in fine litter debris from the mechanical cutting could influence future wildfire risk, and this needs further research. Results have been submitted to Ecological Solutions and Evidence and currently in revision.

3. **How do our ancient woodlands function and how successful is woodland restoration?** Contact: andy.taylor@hutton.ac.uk

   The UKs Atlantic rainforests are globally important habitats rich in unique biodiversity and efforts to save these habitats include the conversion and restoration of commercial conifer plantations established within existing ancient oakwoods (PAWS). This project focuses on establishing an evidence base on the impacts belowground on biodiversity and ecosystem functioning associated with PAWS creation and subsequent restoration efforts involving the removal the conifers. In particular, we are characterising soil biodiversity communities of the desired endpoint of pristine temperate rainforest oakwoods, and the impacted starting point under existing PAWS. Without these data it is not possible to assess restoration progress. In collaboration with FLS we have completed a two-year intensive field study at Glen Creran near Oban which enabled us to start filling this knowledge gap to determine the recovery trajectories of soil biodiversity communities in areas of active restoration relative to the two end points. A new PAWS restoration study is underway at Dalavich on the side of Loch Awe.

Protected areas to tackle biodiversity loss now, and for the future

Lead PI: **Ruth Mitchell** (ruth.mitchell@hutton.ac.uk)

Overall project aim:

To improve our understanding of how to design effective protected area networks against a backdrop of rapid environmental change and how to measure the success of protected areas.

Key policy topics:

Climate change adaptation, Protected areas, 30 x 30, OECMs

Policy relevance:

- Work on Other Effective Conservation Measures (OECM) is directly feeding into Scottish Government and NatureScot's thinking on the development of OECMs work.
- Work on natural genetic variation in trees to increase resilience will feed into Protected areas and 30 x 30 policies. It also feeds into Scotland's Forestry Strategy (e.g. seed sourcing, nursery practices and tree planting initiatives).
- Addressing prioritized knowledge gaps identified by members of the Alliance for Scotland's Rainforest,
- Interacting with the NatureScot Delivering Healthy Ecosystems team. Specifically, working on designing a resilience assessment for protected areas, or a risk assessment of future threats to sites and what action we might take now to reduce their impact.

Recent highlights and outputs:

- Website: https://sefari.scot/research/projects/protected-areas-to-tackle-biodiversity-loss-now-and-for-the-future
- Does protected area status prevent biodiversity decline in plant communities? Ruth Mitchell & Jackie Potts (2024) SEFARI case study
- Tree nursery environments and their effect on early trait variation
- Significant and persistent carryover effects in Scots pine

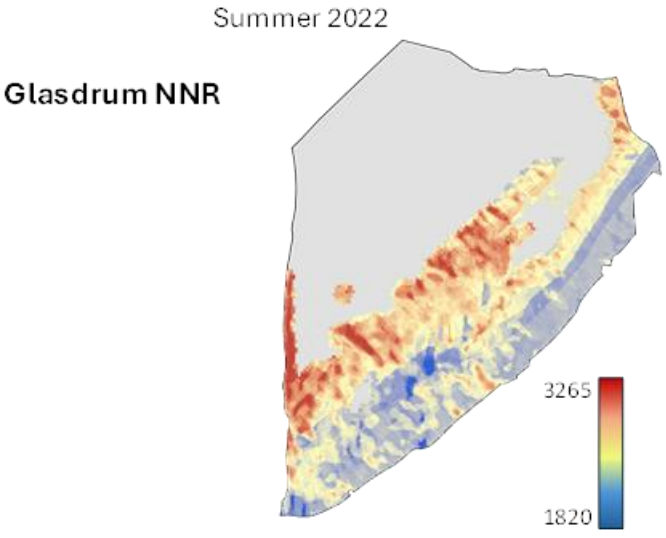
Protected areas to tackle biodiversity loss now, and for the future

Specific objectives and summary of recent work

1. **How do we support and enable participation in OECMs in Scotland?** Contact: hannah.grist@sruc.ac.uk
   In the past few months we have been working on understanding international best practice around participation in OECMs, talking to colleagues in California and Quebec to understand their successes and challenges around rollout. We have completed a literature review highlighting important themes that we are using to develop a discussion workshop and knowledge exchange event. Coming up, Scottish Government work on OECM's has progressed to pilot areas, and we are planning to work on the next steps for this research alongside the evaluation of these initial pilots.

2. **How can protected areas ensure that threatened genetic diversity is safeguarded**? Contact: jenni.stockan@hutton.ac.uk
   Analysis of the early years of our Scots Pine provenance-progeny trial has highlighted the importance of the nursery environment which has significant effects on tree growth, form, phenological and survival traits. These effects can be partially mitigated by raising trees in nurseries close to where they are planted out. We have also demonstrated that these effects can last at least 10 years post planting (paper submitted). Genotyping work to assess genetic diversity is complete and we have helped carry out surveys of the pine fungal pathogen *Curreya* on our trial sites, both datasets are currently being analysed

3. **Can we identify refugia for species which are unlikely to disperse quickly in the face of a changing climate**? Contact: c.ellis@rbge.ac.uk
   This work has focussed on understanding the microclimates within rainforests and if we can manipulate them support species in the face of a changing climate. Building on the initial modelling of microclimates, additional external funding has been secured (DEFRA) in partnership with Forest Research, to expand monitoring and analysis of habitat suitability for temperate rainforest indicators across sites in Scotland and Southwest England (£50,000), and to support spatial targeting of forest restoration. Locations are being planned for a second phase of microclimatic monitoring, expected to commence in September 2025. The map here provides an example of preliminary output for one of Scotland's temperate rainforest NNRs, showing values for mean daily vapour pressure deficit within woodland areas, at a 5 metre scale (for the period summer 2022).



4. **How do we measure the success of our protected areas?** Contact: ruth.mitchell@hutton.ac.uk
   We have continued to develop a resilience plan for protected areas, focussing on woodlands. The plan aims to help managers identify future drivers of change within protected areas. These may either be drivers that are currently present outside the site but yet at the site, such as Rhododendron or tree disease or drivers that are not yet present e.g. future climate scenarios. The resilience plans aim to identify if action can be taken now to reduce the impact of these future drivers. We have worked through the plan at two sites with NatureScot staff.

Assessing the impact of changing migratory patterns, population size and diversity of greylag geese on livestock and public health

Lead PI: **Eleanor Watson** (eleanor.watson@moredun.ac.uk)

Overall project aim:

To investigate the microbial risks associated with rapidly expanded resident and migratory greylag goose populations on Orkney, and assess economic, conservation and social impacts.

Key policy topics:

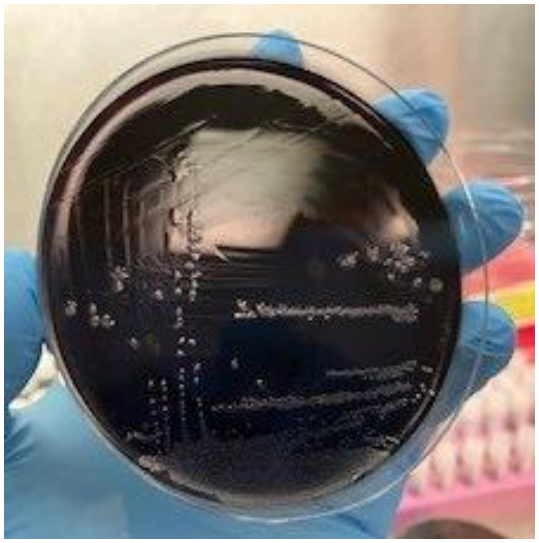
Climate change, One Health, Farming and Nature, cross-policy impacts

Policy relevance:

This One Health project addresses questions surrounding disease risks associated with expanded populations of greylag geese. The project also aims to also showcase experiences and considerations for studies with cross-policy impacts, particularly at the wildlife / farming interface.

Methods and approaches will inform further studies where disease risks in changing environments are assessed. This includes monitoring changes driven by climate or uptake of regenerative farming practices.

Project outputs will also support pathogen surveillance and monitoring of wild bird populations to inform risk management.



Recent highlights and outputs:

- Members of the project team secured funding from SEFARI Gateway for the project “Scoping a route to a locally driven approach to agricultural research in Orkney”.
- The project lead attended the UK-Iceland Higher Education Forum in Reykjavik to explore collaborative opportunities in biodiversity and agriculture research.
- The project was highlighted during the Scottish DNA Hub meeting held at Moredun Research Institute on the 6th February 2025 and during a Scotland Food & Drink Partnership Sustainability Discussion in January 2025.

Assessing the impact of changing migratory patterns, population size and diversity of greylag geese on livestock and public health

Specific objectives and summary of recent work

1. **Investigate transmission of Cryptosporidium parvum, Campylobacter and antimicrobial resistance between geese, calves and cattle and the wider environment.** Contacts: clare.hamilton@moredun.ac.uk (Cryptosporidium), eleanor.watson@moredun.ac.uk (Campylobacter) and nuno.silva@moredun.ac.uk (antimicrobial resistance)

   Goose faecal samples have been collected in Orkney during the wintering season (November 2022) and goose, cattle, calf and environmental samples have been collected during pre-and post-turnout of calves to pasture (April and June 2023).

2. All samples have been processed to isolate Campylobacter and Cryptosporidium. DNA sequencing data has been generated to identify pathogen genotypes, which is being used to assess likelihood of transmission between cattle, calves and geese.

   Methods to extract bacterial DNA from archived faecal samples for detection of antimicrobial resistance genes (ARGs) have been assessed and optimised. qPCR array technology will be used to identify ARGs within samples in year 4, and allow carriage of ARGs by geese, cattle and calves to be compared.

3. **Development of molecular tools to genotype geese.** Contact: keith.ballingall@moredun.ac.uk

   Methods to extract goose DNA from faeces have been assessed and optimised and DNA of sufficient quality and quantity has successfully been extracted for molecular analysis. Methods to amplify loci of interest for goose genotyping have been optimised for DNA sequencing. Methods are now being applied to field samples and analysis is on-going. Samples from Barnacle geese have also been collected through a collaboration with NatureScot and the University of Edinburgh to progress the development of these molecular methods to support avian flu surveillance.

4. **Engage with stakeholder groups to inform project progression, assess impact of findings and highlight successful approaches for related studies.** Contact: eleanor.watson@moredun.ac.uk and beth.wells@moredun.ac.uk

   The project team have held discussions with farmers and other stakeholders in Lewis and Shetland, where numbers of geese have also risen. Members of the project team met with Liam McArthur, MSP for Orkney Islands to discuss SEFARI projects.

Seeking multiple benefits from natural carbon stores in the uplands

Lead PI: **Davy McCracken** (davy.mccracken@sruc.ac.uk)

Overall project aim:

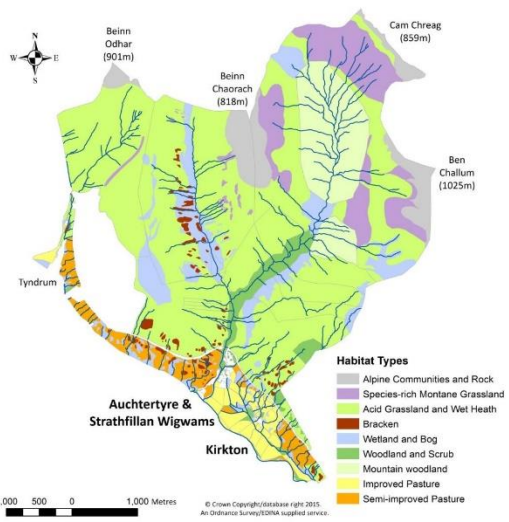
Explore the relationship between carbon storage, biodiversity conservation and flood mitigation to detect synergies and trade-offs and identify land management practices that optimise the benefits derived

Key policy topics:

Climate adaptation; Agricultural policy reform; Scottish Biodiversity Strategy monitoring and evaluation; Where to focus actions on different drivers of change

Policy relevance:

- As part of this project we are using acoustic devices to monitor birds and bats, camera traps to survey small mammals and river level sensors to assess how much different habitats on an upland farm hold back water flow after extreme rainfall events.
- Given the inclusion of biodiversity and wider environmental conditions within the next agricultural support package, we are developing guidance material targeted at farmers and crofters to help them use acoustic technology to monitor biodiversity on their farms and crofts.
- We are working with NatureScot to help test and refine the Biodiversity App and Biodiversity Audit process
- Members of the project team sit on the Academic Advisory Group providing input to the Agricultural Reform Implementation Oversight Board and the Programme Advisory Group for the development of Scotland's Biodiversity Strategy to 2045



Recent highlights and outputs:

- McCracken, D. 2025. Rural college goes global to raise rangeland knowledge. *Press & Journal*, 19th April 2025
- McCracken, D. 2025. 'Living labs' can help link farming and nature. *Press & Journal*, 1st February 2025
- Fisher, H. & McCracken, D. 2025. Combating nature loss: Scottish Biodiversity Strategy. *Farm Advisory Service Podcast*, 28th January 2025

Seeking multiple benefits from natural carbon stores in the uplands

Specific objectives and summary of recent work

Our work is focused on SRUC's Kirkton and Auchtertyre farms where we are focusing on carbon storage (in the soil, and vegetation), biodiversity conservation and flood mitigation.

1. **Ground-truth existing maps of carbon storage potential and flood mitigation using on the ground surveys and environmental sensors to monitor rainfall and water flow, and expand the spatial coverage of these maps to include all predominant habitats on the estate.**

   All progressing on track.

2. **Supplement existing biodiversity datasets, through the collection of new biodiversity data to expand spatial coverage to cover all predominant habitats present on the farm, and implement innovative approaches to monitor biodiversity (e.g. acoustic sensors and camera traps)**

   Audiomoth acoustic loggers and camera traps have been deployed on lowland and upland sites for the third year. We have developed a guidance document for the use of Audiomoth loggers for detecting bird occurrence, with the aim of helping users identify and remove false positives.

3. **Trial scorecards developed under NatureScot's project Piloting an Outcomes Based Approach (POBAS) in Scotland and the NatureScot Civtech Challenge Habitat Quality app to determine how effective proposed scorecards are as indicators of wider biodiversity**

   Liaison with NatureScot ongoing. A visit to the farms scheduled in September 2024 by a group number of NatureScot colleagues working on the biodiversity audit process has been postponed to a later date [TBC].

4. **Quantify the relationships between metrics relating to carbon storage, biodiversity conservation and flood mitigation to identify synergies and trade-offs between these key ecosystem services, and identify land management practices that optimise these multiple benefits**

   To complete in Year 4

5. **Utilise data from Kirkton and Auchtertyre farms to create spatial models of carbon storage, biodiversity conservation potential and flood mitigation for part of the upper River Tay catchment, and collect additional data to ground-truth these at several sites, to test the scalability of findings generated during this study**

   To complete in Year 5. We are in discussions with surrounding landowners within Loch Lomond & The Trossachs National Park with regard to where it may be feasible to collect data on representative habitats on their farms.

ELPEG Policy Update

The Natural Environment (Scotland) Bill was introduced to the Scottish Parliament on 19 February 2025. The Bill:

- places a duty on Scottish Ministers to set statutory targets for nature restoration,
- creates a power to allow for future amendments to Environmental Impact Assessment legislation and the 1994 Habitats Regulations,
- modernises the aims of National Parks and powers of National Park Authorities,
- reforms the way in which deer are managed

Statutory targets form one of three key parts of the Scottish Government's Strategic Framework for Biodiversity, alongside the Scottish Biodiversity Strategy and the underpinning Delivery Plans. The Bill and its accompanying documents can be viewed on the Scottish Parliament website.

The Bill is currently being scrutinised at Stage 1 by the Scottish Parliament's Rural Affairs and Islands Committee. The Committee has issued a call for views on the Bill which closes on 9 May 2025.

How to find out more about related work on Soils, Water and Natural Capital

Theme D - Natural Resources is one of five themes in the Strategic Research Programme. The others are A Plant and Animal Health, B Sustainable Food System and Supply, C Human impacts on the Environment and E Rural Futures.

Within Theme D there are five Topics D1 Air Quality, D2 Water (inc Flooding), D3 Soils, D4 Biodiversity, D5 Natural Capital. ELPEG and ELSEG will largely focus on D4 Biodiversity and the biodiversity work in D1 Air Quality.

Each Topic has their own mechanisms for engagement with policy and with stakeholders:

D1 – Air pollution

The project on ammonia emissions is working specifically with the CAFS2 (Cleaner Air for Scotland Strategy) Agriculture and Environment Working Group (AEWG) and the project on particulates with the CAFS2 Domestic Emissions Working Group (DEWG). The project on air pollution and biodiversity is engaging with ELPEG and ELSEG. Contact Andrea.Britton@hutton.ac.uk for further details.

D2 - Water (inc Flooding)

This Topic has established an engagement group with SG policy (teams working on Water and Environment, Flooding, Water Industry team, Drinking Water Quality) and a wider engagement group (including NatureScot, SEPA, Councils, Scottish Water, NHS, land managers and communities). The project has two new webpages with information about ongoing work:

Achieving multi-purpose nature-based solutions - James Hutton Institute

Emerging water futures - James Hutton Institute

Contact Mark.Wilkinson@hutton.ac.uk for further details about work in any of the projects within the water topic.

D3 - Soils

A copy of the latest newsletter produced by this Topic “The Soil Sentinel” is attached. Contact Eric.Paterson@hutton.ac.uk or Kenneth.Loades@hutton.ac.uk for further details.

D5 - Natural Capital

Each project in the topic area has a different mix of key stakeholders. These include ONS, NatureScot, Defra, SEPA and the Office of the Chief Economic Advisor (OCEA), but also go beyond these, as a key rationale for working with natural capital is mainstreaming consideration of nature across sectors.

The team working on ‘Participatory approaches to widen the scope of natural capital valuation’ (JHI-D5-1) published a paper that identifies: 1) the lack of a holistic understanding of forest multifunctionality; 2) the absence of a framework for operationalizing sustainability of socio-ecological systems; 3) the gaps in valuing of biodiversity, landscapes, and cultural heritage; 4) how to facilitate the uptake of nature-based solutions, and sustained delivery of ecosystem services. Martino et al (2024). A Classification and Interpretation of Methodological Approaches to Pursue Natural Capital Valuation in Forest Research, *Forests,* **15**(10)**,** 1716. https://www.mdpi.com/1999-4907/15/10/1716

Natural capital is often associated with private sector, but the way of thinking and datasets can potentially be useful to many sectors, including the work of policy-makers. The team working on ‘Galvanising Change via Natural Capital’ (JHI-D5-3) met with international experts to discuss how to encourage use of natural capital in policy making, and in January published a briefing summarised cross-cutting lessons. It is available at https://www.hutton.ac.uk/wp-content/uploads/2025/01/2025-

Jan-Workshop-on-NC-in-policy-briefing.pdf Also on the theme of policy-making, the team were grateful to recently have in-depth discussions with colleagues working on the Agricultural Reform Programme and their views on natural capital and evidence use – this briefing summarises the findings of that work: https://www.hutton.ac.uk/wp-content/uploads/2024/05/25_04_30_Briefing_AgriChats-report_final.pdf

Contact Kerry.Waylen@hutton.ac.uk for further details about the Natural Capital Topic.