

Ecosystems and Land Use Policy Engagement Group (ELPEG) Bulletin – October 2025

Introduction

Welcome to our eighth ELPEG bulletin of the 2022-2027 RESAS Strategic Research Programme. The aim of this bulletin is to provide policy makers with updates on biodiversity research 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).

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.

Please do pass this bulletin onto any colleagues who would be interested in the work.

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



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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. During summer 2023-2025 we resurveyed vegetation and sampled soils and moss at 319 locations across Scotland. Chemical analysis and DNA sequencing of samples collected during 2025 is currently underway and will complete the dataset. Analysis will focus on long term change in vegetation communities and understanding 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 are conducting DNA-based field surveys to investigate how nitrogen deposition and climate influence fungal communities associated with birch, oak and pine woodlands. Field surveys during 2022-2024 sampled 54 semi-natural woodland sites from across Scotland plus an additional 37 Scots pine and Sitka spruce plantations sampled in collaboration with Forestry and Land Scotland. Three DNA markers were used to detect a wide range of soil organisms, with 23,079 taxa detected across the 91 sites including 466 ectomycorrhizal fungi. Initial analysis characterized soil communities associated with each woodland type, and the analysis is now being extended to assess how the 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

Based on observations during the alpine repeat survey study that generalist upland mosses appear to be becoming more frequent in alpine moss heaths, we have been running lab-based experiments to test interactive nitrogen-warming effects on competition between 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 using existing datasets to model risks to Scottish ecosystems from interactive impacts of nitrogen deposition and climate change. Alpine habitats have been selected as a case study. We aim to develop a climate envelope style model to predict impacts of projected climate change scenarios on a range of alpine habitats and to combine this with pollutant deposition models to determine those areas/habitats exposed to greatest combined risk. Development of the model requires suitable plant community mapping data and we are currently focused on developing this.

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 covering Scotland and Cumbria (as a heavily nitrogen polluted comparator). Vegetation and soils have been sampled to assess total nitrogen contents and element ratios which are useful indicators of nitrogen impacts. Fieldwork was completed during 2025 and the final samples are being processed.



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, Environment Strategy, Protected areas, Green infrastructure, Wellbeing economy, Agriculture, Woodlands and forests

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 forest therapy walks as an intervention to shift nature values is related to our [Reciprocal Care for Nature and Wellbeing](#) project which focuses on mechanisms to support nature engagement for health and wellbeing. These respond to policy interest in the nexus across urban nature, wellbeing and the people-nature

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 the four game-based workshops (Phase 2) with different community groups. These workshops combined both deliberative and future planning / scenario building work to vision nature-economy relationships in Scotland. Workshop data are currently being analysed. Findings will be combined with those derived from the Q study interviews (Phase 1) with civil sector workers across Scottish Government to inform a final deliberative workshop (Phase 3). This last workshop will invite participants from both previous phases to co-develop 'alternative' framings of nature-economy relationships. Development of the workshop is being done in consultation with key stakeholders to ensure availability and relevance for policy and practice.
2. **Enabling inclusivity in biodiversity narratives: Developing a digital platform and approach to integrate diverse perspectives into co-generated place-based biodiversity management.** We have continued to refine the functionality of, and content for, our prototype digital platform and approaches to foster inclusion of diverse perspectives into biodiversity conservation and management. To facilitate gathering new stories, the platform now includes a function to submit and publish directly within it. We co-designed with stakeholders from our case study area (Cairngorms National Park), an approach and materials for testing the Platform as a tool for inclusivity. Our final round of field-testing for the Platform began this autumn.

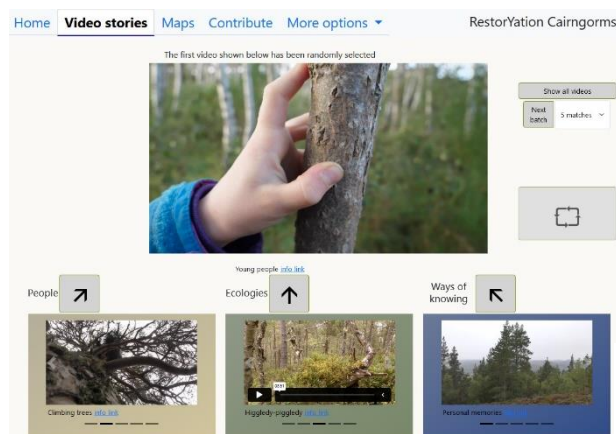


Image: Screenshot from draft digital platform prototype

3. **Transformative biodiversity research and change: Identifying interventions to support cross boundary collaboration for biodiversity impact in agricultural landscapes.** A final report is available upon request for this completed research. Using a case study approach, we 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.** Our feasibility and acceptability study explores the potential of forest therapy walks as a lever for change in the people-nature relationship, and as an intervention suitable for green social prescribing to support wellbeing in urban areas. Analysis of data from quantitative, qualitative, and arts-based methods is examining participants' experience of the different intervention components (programme, activity, group, nature), and the feasibility of integrating research into forest therapy walks for larger-scale investigation. Initial insight suggests participants found the urban woodland a comfortable space. While anthropogenic noise was at times distracting, the space was generally experienced as quiet, secluded, and calming. Participants noted the value of this type of environment being available to support urban-based forest therapy walks. Analysis is ongoing.
5. **Green/ blue infrastructure for people and nature: Assessing the role urban nature plays.** We include two research strands to further understand people-nature relationships in urban areas. A field-based study examines quality-of-life assessment as a tool for capturing effects of change in ecological quality and availability of green space. Analysis of responses (quantitative, qualitative) from over 180 adult residents in our Cumbernauld case study is progressing. A desk-based review explores preventative spend and nature-based programmes. Grey literature examples from across the UK highlight a focus on mental health issues, and a range of different intervention types. Comparators to assess benefit also vary, from standardised values for avoided healthcare to direct valuation of reported mental health improvement. These suggest a wide variety of outcomes in terms of benefit-cost ratio. A search of peer-review literature is underway.

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, INNS, 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, stuart.smith@hutton.ac.uk
Analysis of tree colonisation patterns is revealing a number of relationships between grazing and establishment. Seedling and sapling densities are about four times higher in the ungrazed plots than the most heavily grazed plots and are higher in dry grassland communities than in wetter areas. Colonisation by birch appears to be facilitated by willow, possibly through access to existing mycorrhizae.
- 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. Time-varying autocorrelation analysis of a focal species, the Green spruce aphid, has shown that warmer temperatures from mid-January are associated with better overwinter survival. Results have been presented to agriculture stakeholders and statisticians at different 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.stockan@hutton.ac.uk
Our "future drought scenarios" experiment on native Scots pine saplings has just completed the 2025 season of experimental drought treatments. We are continuing to monitor bud burst, growth and survival of young pines in each treatment group. Evidence of both immediate and delayed responses are emerging from the different treatments, with early data analysis indicating differences in resilience by forest origin. Further data 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. The monitoring work continued into the third 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
Thirteen frameworks for measuring impact of INNS were reviewed and assessed for suitability of application to heath and moorland habitats. The first draft of a combined framework has been created, and documentation for use is in progress. This framework will be tested with Sitka spruce encroachment over the next year.



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:

- Burns et al. (2025) State of Nature 2023 terrestrial and freshwater animal dataset for the United Kingdom and its constituent countries <https://doi.org/10.1007/s10661-025-14352-4>

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 and to update existing checklists.

2. **Improved reporting** Contact: robin.pakeman@hutton.ac.uk

The paper assessing the impact of different weighting methods has been published in Environmental Monitoring and Assessment. The State of Nature 2023 terrestrial and freshwater animal dataset for the United Kingdom and its constituent countries has been published in Data in Brief creating an accessible record that can be further analysed by the scientific community. Current analysis is focused on developing new species climate indicators for invertebrates.

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 was extracted and sequences from all of the samples along with basic analyses of soil pH and carbon and nitrogen content. The complete DNA dataset includes 67 million sequence reads representing almost 49 thousand taxa (8,646 fungi, 27,322 bacteria and archaea, and 12,849 eukaryotes). This dataset is globally unique in its scale and biodiversity coverage, and we are now working on analysing the data to understand how soil biodiversity varies across Scotland's alpine zone and how it is affected by drivers such as climate, vegetation, soils and pollution gradients.

4. **Monitoring approaches for outcomes focused interventions** Contact: cathy.hawes@hutton.ac.uk

A book chapter has been drafted: "Improving Biodiversity Monitoring for Farmers" which will be published in 'Improving biodiversity monitoring of agricultural landscapes (ed. Dr Felix Herzog)', Burleigh Dodds Science Publishing. This will present a suite of indicators suitable for farmers to monitor outcomes of biodiversity-friendly farming practices and highlight opportunities for automated monitoring, tools and apps to help improve objectivity and reliability of citizen science style exercises. A kick-off meeting has taken place for stakeholders for the Bio4Ag Toolbox project and we are currently collating feedback on content and structure.



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 (work package ; 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. This project focuses on how we can assess and maximise equitable benefit flows from past and future woodland schemes across urban and rural 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 in Craigmillar Castle Park, Edinburgh. Initial findings from this fieldwork, such as how the benefits flowing to different types of local residents have been changing over time, have been presented back in the park to forestry sector stakeholders. As part of our rural case study, we have now started our field work in and around Oban with the launch of a public survey on use of local woodlands (for recreation and livelihoods).

2. **WP2. 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
No work was scheduled in this work package during this year.

3. **How do our ancient woodlands function and how successful is woodland restoration?**

Contact: andy.taylor@hutton.ac.uk

This work package examines the impacts of planting conifers (PAWS) on former seminatural oak woodlands and the ongoing efforts to restore the oak woods. We have so far carried out a two-year intensive field study at Glen Creran near Oban which enabled us to start filling knowledge gaps with respect to the end of points of the gradient from seminatural woodland to conifer plantation. This study showed striking differences between soil biodiversity and C and nutrient cycling between the end points and the restored areas. A new study of PAWS restoration was established in the spring of 2025 in collaboration with FLS at Dalavich near Loch Awe. Five sites were investigated with a seminatural SSSI oakwood at one end of the spectrum as the desired endpoint, and an old 2nd rotation Sitka spruce stand as the starting point. Three restoration ages (10, 15-20, ca. 35 years) were included to examine restoration progress. Soil biodiversity is being investigated using DNA barcoding, and soil probes have measured nutrient cycling and decomposition assays were used as proxies for C cycling. Combined, these data, and those of the Glen Creran study, will provide functional biodiversity profiles of each study site and indications on how the soil is responding to restoration efforts.

The end points of the restoration gradient are shown below. On the left is a typical PAWS area with closed-canopy Sitka spruce, and on the right, an area in the SSSI Oak woodland at Dalavich – the desired endpoint of restoration efforts.



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.

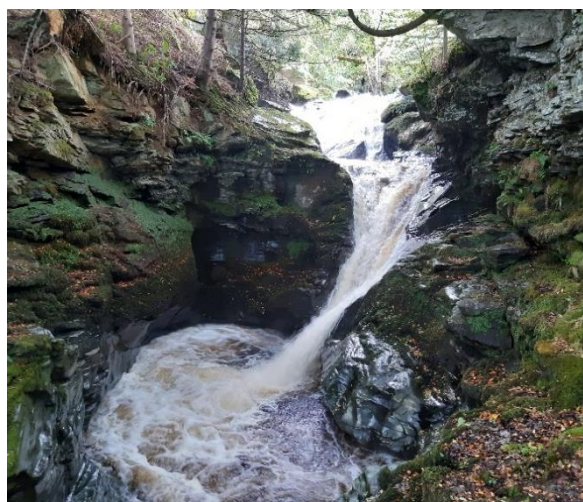


Key policy topics:

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
We have recently completed a policy brief on international learning on implementing participatory biodiversity conservation measures such as OECMs (now called Nature30 in Scotland). We participated in a Naturescot Nature Network launch workshop, providing a workshop on engaging with communities and the links to Nature30. We are currently working on interviews with community stakeholders on the barriers and opportunities offered by Nature30 for community groups to be recognized for their contribution to biodiversity conservation.
- 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 are working on a paper analysing the carry over effects of these early nursery environments, which in some cases can last at least 10 years. Following last years' surveys for the Scots Pine pathogen *Curreya pityophila*, we currently have spore traps deployed to further monitor its abundance and distribution.
- 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 concluded an analysis of climate change resilience for five of Scotland's woodland NNRs in the globally-important temperate rainforest zone. The results are under review for publication. An extended analysis will include spatial targeting for woodland planting to secure climate change refugia in Glencoe NNR (NTS as a stakeholder), and an agreement has been reached on further microclimatic monitoring in Glen Nant NNR (FLS as a stakeholder), to better understand the climate change response of temperate rainforest species.
- 4. How do we measure the success of our protected areas?** Contact: ruth.mitchell@hutton.ac.uk
We have worked through our resilience plan for woodland protected areas with a couple of woodland site managers. This has continued to develop our thinking and refine the resilience plan. 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 are currently working on plans for alpine and coastal habitats and assessing how much of the woodland assessment for resilience is also applicable to these habitats.



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.

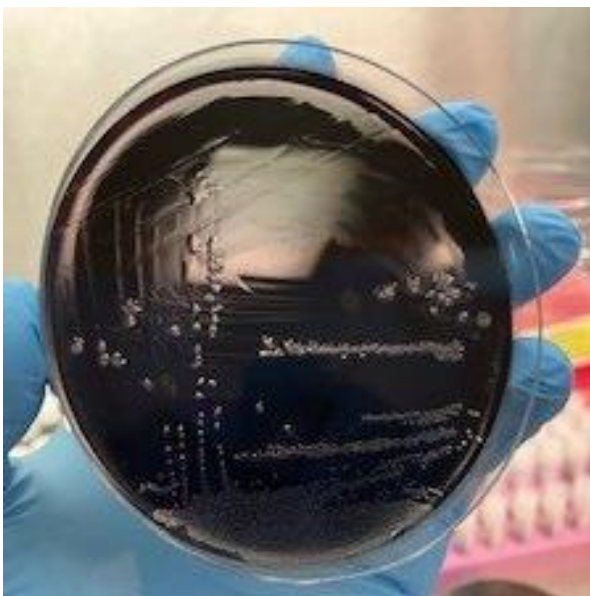


Key policy topics:

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 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:

- Results were presented at CampyUK 2025 conference at the University of Oxford in September
- Reports summarising *Cryptosporidium* results sent to participating farmers
- Project team participated in workshop: "Updating the Scottish One Health AMR Register (SOHAR)"

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*), eleonor.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).

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. High-throughput analysis of antimicrobial resistance genes (ARGs) using qPCR array technology is being carried out to allow carriage of ARGs by geese, cattle and calves to be compared.

2. **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.
3. **Engage with stakeholder groups to inform project progression, assess impact of findings and highlight successful approaches for related studies.** Contact: eleonor.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. Reports summarising *Cryptosporidium* results have been sent to participating farmers.



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.

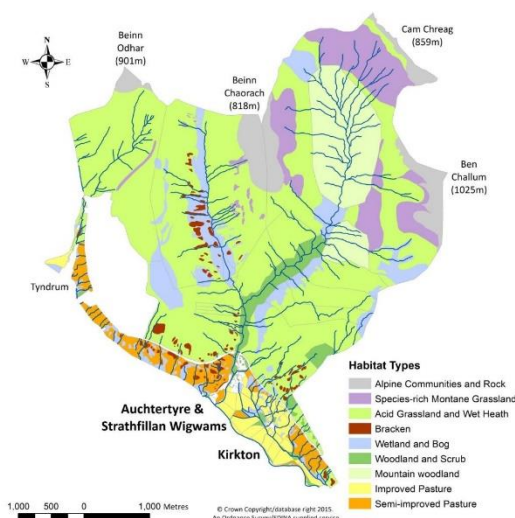


Key policy topics:

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.

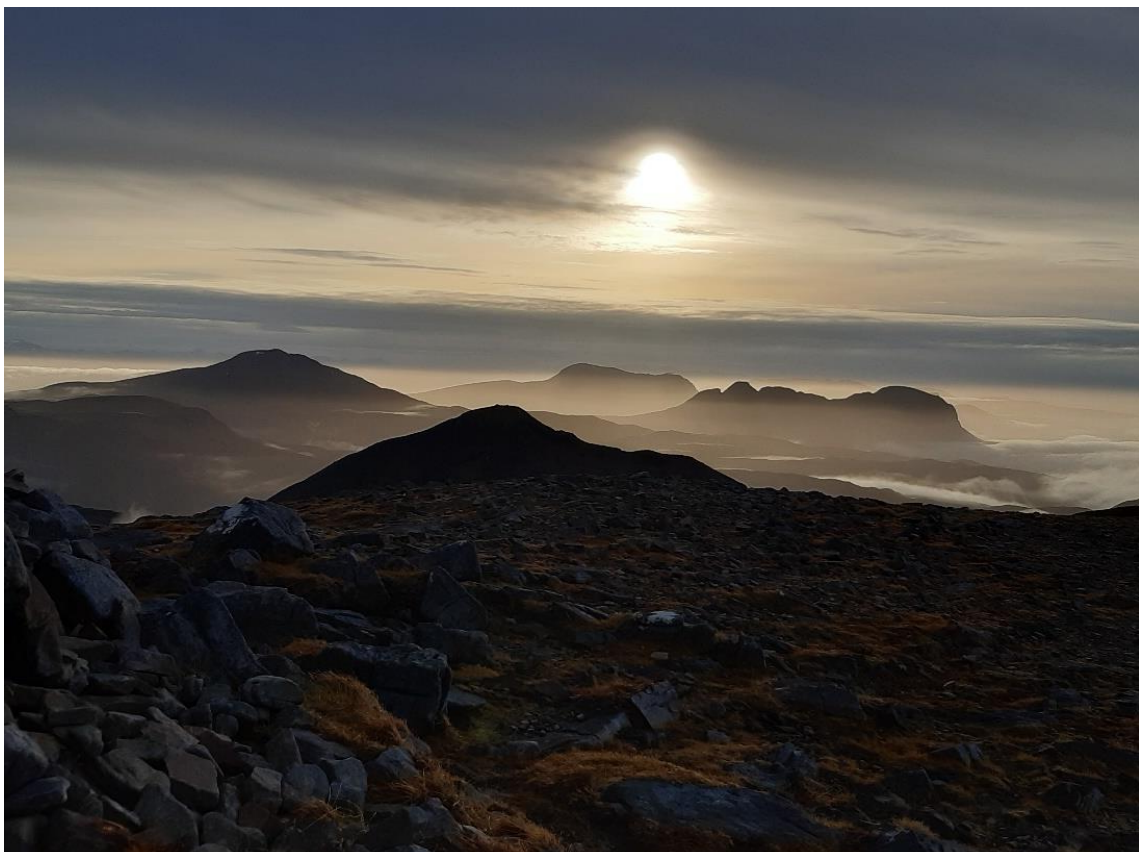
- 1. Ground-truth existing maps of carbon storage potential and flood mitigation using on the ground surveys and environmental sensors to monitor rainfall and water flow, and expand the spatial coverage of these maps to include all predominant habitats on the estate.**
All progressing on track.
- 2. 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

Natural Environment Bill update:

- The Natural Environment (Scotland) Bill was introduced into Scottish Parliament in February 2025. This Bill provides a framework for setting, reviewing and reporting on statutory targets for improving biodiversity.
- These targets will be based on expert scientific advice and the target topics are defined as;
 - The condition or extend of any habitat
 - The status of threatened species
 - The environmental conditions for nature regenerations
- There were two additional target topics of 'Ecosystem Health and Integrity' (EHI) and 'Citizens and society understanding, benefitting from and contributing to nature' were assessed by the Biodiversity Programme Advisory Group (PAG)- a group of experts to advise the Scottish Government on the development of the Strategic Framework for Biodiversity- as having merit but there is not currently an established approach to assessing how targets are made under these topics could be measured
- RESAS has therefore commissioned research which aims to identify, develop and incorporate system indicators for the 'Ecosystem health and integrity' target topic into the work, being led by NatureScot, on the Red List of Ecosystems for Scotland.
- This research is being led by the UK Centre for Ecology and Hydrology in consortium with the James Hutton Institute and the Scottish Association of Marine Science (SAMS). The project aims be completed in Autumn 2026.
- With the PAG we are entering our final step of developing the scientific recommendations for nature restoration targets in the Natural Environment Bill. This involves a number of workshops up until the end of this year that will make recommendations for the setting of targets.



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 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

Completion of work on natural capital valuation of agricultural soil. The SRUC project ‘Understanding the value of Scotland’s agricultural soil natural capital’ (SRUC-D5-1) ended in March 2025. Our final output ‘[Valuation and mapping of cultivated soil ecosystem services](#)’ reports on a discrete choice valuation of potential improvements to soil health through adoption of more sustainable practices. This demonstrated public support for multiple benefits including improved water quality, increased flood and drought risk resilience, increased biodiversity and increased soil carbon. Recognising that some of our soils already provide these benefits to some extent due to their properties, we applied our valuation results to soil mapping to identify areas where improved soil management could be targeted. Those interested in soil health and soil management may also want to check the JHI-D5-2 team’s 2024 reports on how climate change will affect soil properties – check [Report: Climate change effects on soil properties and functions: the case of soil water balance](#) and [Report: Climate change, soil water balance and risks to soil microbiological function](#).

Governing high-integrity ecosystem markets: what this means for biodiversity policy A new paper from ‘[Galvanising Change via Natural Capital](#)’ (JHI D5-3) recommends how to scale credible carbon and wider ecosystem markets while protecting nature and communities. It provides the first UK-wide overview of compliance and voluntary carbon and other ecosystem markets, maps the key

market actors, and distils 15 principles covering governance, measurement, reporting and verification, and benefits beyond carbon. A practical governance hierarchy is given, proposing how national policy, assurance infrastructure and market rules can work together so projects deliver additional, verifiable outcomes for biodiversity and people, whilst avoiding perverse effects. Clear national oversight and interoperable monitoring, reporting and verification (MRV) systems are recommended, to ensure biodiversity gains alongside emissions reduction, including for inseting and emerging credit types. These proposals align with ongoing Scottish work to embed natural capital approaches in decision making and to steer private finance toward nature recovery. [Read the paper](#) or [View slides presented to the Cross-Party Group on Rural Policy at Scottish Parliament](#) or [Listen to the lead author discuss the paper in the Financing Nature Podcast](#)

Emerging insights on working with natural capital in the public sector. The JHI-D5-3 team has also produced another new paper [Can natural capital help national-level policy-makers to embed sustainability considerations? Insights from Scotland](#) This shows that there is familiarity with natural capital; but it is not often something incorporated into the work of policy development. Many perceived a need to change to embed sustainability, but expected natural capital to be relevant to someone else, rather than their own role or department. Scotland is well placed to further embed natural capital, but efforts are needed to capitalise on the existing tools and data available. The team are currently exploring opportunities to go further with staff working on agricultural policy, and will also discuss with other departments in 2026.

New framework to support participatory valuation of local natural capital. The team working on '[Participatory approaches to widen the scope of natural capital valuation](#)' (JHI-D5-1) recently tested [a valuation framework](#) at Glensaugh farm, supported by a range of social and economic methods and tools to assess natural capital. Feedback from this pilot indicates that the approach has the promise to elicit plural values and inform local decision-making. The test has generated interest among local users for evaluating the natural capital at the Loch Saugh and building social capital. After finalising the framework (Dec 25) the team will suggest how [Natural Capital Community Partnerships](#) could use the framework, supporting community involvement in decisions over local natural capital.

A new modelling approach to assess spatial wildfire danger. There is considerable interest in the growing risk of wildfires, including in the national parks. A new modelling approach released earlier this year, by the team working on [Climate Change Impacts on Natural Capital](#) (JHI-D5-2), should help to understand those risks. [Report: Development of a modelling approach for conducting spatial assessments of future wildfire danger in Scotland](#)

Identifying habitats most at risk due to environmental change. Building on their earlier work to understand the effects of climate change on natural capital, earlier this year the JHI-D5-2 team released a [Report: Identifying habitats at risk of species loss due to environmental change](#) which shows alpine habitats are most at risk of increased temperatures or changing rainfall patterns. Meanwhile, grassland habitats, particularly fertile ones appeared most at compositional risk in terms of increased nitrogen pollution, whereas recovery from past levels of nitrogen deposition may see biggest changes in wetlands. The implications for other habitats – such as moorlands, grasslands and wetlands – depends other factors such as disturbance and grazing levels.

Building insights of how land managers understand risks related to climate change. Regardless of risks projects in scientific reports, people act is shaped by their perceptions. Earlier this year, the JHI-D5-2 team released a report into how land managers understand climate change related risks, based on a small survey and interviews. The small sample report high awareness, not only of flood, drought and fire but also more systemic risks arising from a warming and potentially wetter climate. [Report: Assessment of land manager risk perceptions in relation to natural capital](#)