

Ecosystem and Landuse Policy Group (ELPEG) Bulletin – October 2024

Introduction

Welcome to this, our fifth 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).

We have changed the format of this bulletin. Each project now 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



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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 the last 50 years, to examine how nitrogen and climate change are affecting plant and soil biodiversity in alpine habitats. During summer 2024, survey effort was focused on western and southern mountain areas. We have now resurveyed vegetation and sampled soils and moss at 198 locations across Scotland. DNA has been extracted from the soils and sent for sequencing to allow analysis of soil biodiversity patterns in relation to pollution and climate drivers. 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 using data from both the National Biodiversity Network and new DNA-based field surveys to investigate how nitrogen deposition and climate affect fungal communities associated with birch, oak and pine woodlands. Field surveys were undertaken in 2022 and 2023, with final sample collection during October 2024. We now have data covering the geographic range of semi-natural woodlands in Scotland. These data are expanding our understanding of fungal and broader soil biodiversity in Scottish woodland soils and will now be analysed to assess how woodland soil communities are influenced by climate and nitrogen deposition and to determine 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 investigated how warming, nitrogen additions and burning affect carbon and nutrient stocks, nutrient cycling and above and belowground biodiversity. Results showed that added nitrogen was no longer present in the vegetation but remained in the soil 12 years after additions ceased, and that there were long lasting impacts on soil fungi. Strong effects of warming and burning were also seen on both ecosystem biogeochemistry and soil biodiversity. The results of this study provide information on the most suitable metrics for monitoring ecosystem recovery from nitrogen deposition, and we have been working with JNCC and UKCEH to develop recommendations for nitrogen recovery indicators.

4. Modelling of nitrogen climate interactions

Contact: mike.rivington@hutton.ac.uk

Starting in 2025, we will be using 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 paired restored and unrestored sites along a nitrogen deposition gradient within Scotland. We have sampled vegetation and soils to assess total nitrogen contents as well as ratios between elements such as carbon to nitrogen or nitrogen to phosphorus which are useful indicators of nitrogen impacts. Six pairs of sites were sampled in 2024, with more sites to be identified for sampling in 2025.



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>
- Understanding nature-economy relationships. Seb O'Connor & Joana Ferreira (2024). Research brief.
- The potential of clustered farming groups to foster transformative change: A qualitative case study. Ishaan Patil, Sarah Pohlschneider & Katherine Irvine (2024 - forthcoming). Research report.
- Assessing the impact of nature engagement programmes using narrative enquiry: The case of Cumbernauld Nature Connections. Alba Juarez-Bourke, Anna Conniff, Hebe Nicholson, Antonia Eastwood & Katherine Irvine (2024 - forthcoming). Research report.

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.**

Our first phase of research is now complete. A literature review (year 1) informed a field-based study of civil sector workers across Scottish Government bodies and institutions (year 2) to identify the diversity of views on nature-economy relationship both broadly and within Scotland. The latter identified three different understandings of nature-economy relations which play out in everyday policy implementation practice. These include: economy as steward of nature; economy as rebalancing relationships; and economy as manager of nature. Details of these, alongside implications, can be found in our research brief (manuscript in prep). Findings have also been disseminated within Scottish Government networks. Our second research phase explores understanding of nature-economy relations within community. Ethics review obtained with workshops to commence.

2. **Enabling inclusivity in biodiversity narratives: Developing a digital platform and approach to integrate diverse perspectives into co-generated place-based biodiversity management.**

We now have a prototype platform that interweaves spatial maps with experiential video stories. We continue to recruit video stories along three axes of marginalization: people (e.g. gender); ecologies (e.g. particular habitat); and ways of knowing (e.g. non-English). These axes were identified through our literature review and stakeholder engagement (years 1-2). The prototype also incorporates newly published stakeholder compiled data (e.g. Gaelic place names), illustrating the feasibility of and potential for a broader set of material to inform platform content. Our ongoing stakeholder partnerships / collaborations will identify opportunities to demonstrate the platform to inform development.

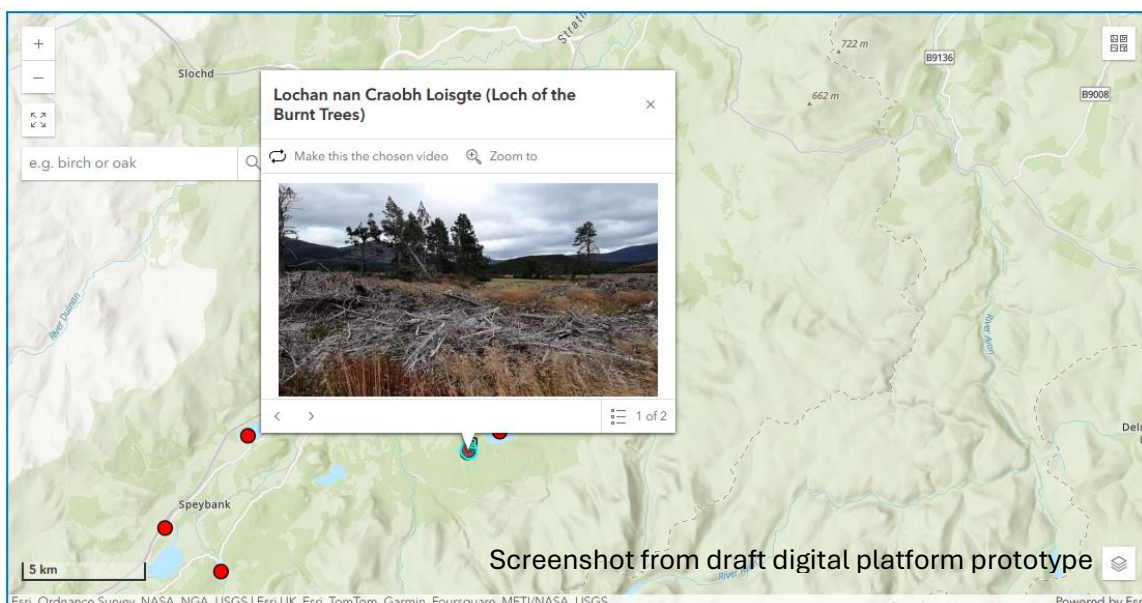
3. **Transformative biodiversity research and change: Identifying interventions to support cross boundary collaboration for biodiversity impact in agricultural landscapes.**

We completed our case study research exploring 'facilitated collaboration' as a type of intervention to support peer learning about 'nature-friendly' practices. Findings suggest that the social learning space that forms within these has potential to enable transformative change in knowledge, identity and practice to begin and to flourish. Findings, alongside implications, can be found in our forthcoming report.

4. **Values: Examining approaches to foster shifts in relationship with and values held about nature.**

We finalised design of and obtained ethics review for our case study research of Forest Therapy as a potential intervention to support change in relationships with and values around nature. This 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.

5. **Green/ blue infrastructure for people and nature: Assessing the role urban nature plays.** Findings from our case study exploration of a narrative inquiry approach to examine impacts from nature engagement programmes can be found in our forthcoming report. Fieldwork for the urban nature and quality of life case study obtained ethics review following stakeholder input for the final questionnaire.



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 policies 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:

- Bačová A., Cooke D.E.L. et al. 2024 Hidden Phytophthora diversity unveiled in tree nurseries of the Czech Republic with traditional and metabarcoding techniques. *European Journal of Plant Pathology* 1-26 <https://doi.org/10.1007/s10658-024-02886-1>
- Mitchell R.J. 2024 A host-based approach for the prioritisation of surveillance of plant pests and pathogens in wild flora and natural habitats in the UK. *Biological Invasions* 26, 1125–1137. <https://doi.org/10.1007/s10530-023-03233-x>

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
We developed methods to assess the spread of trees and shrubs into the experiment as a baseline as local deer numbers will be substantially reduced. The paper assessing the impact of vegetation structure of meadow pipit territory size has been revised - territory sizes are larger where vegetation is denser.
- 2. Collective landscape management of farmland biodiversity** Contact: graham.begg@hutton.ac.uk
We have helped develop guidance and training for cluster farmers and facilitators, and guidance on best-practice and biodiversity monitoring and evaluation. We have engaged with stakeholders, facilitated their engagement with SG, and completed a CXC project "Landscape-scale collaboration to benefit biodiversity and climate change outcomes". A report on the drivers and barriers to the provision of biodiversity and ES and the propagation of costs and benefits throughout the agri-food system has been completed.
- 3. Using long-term aphid monitoring data to assess drivers of biodiversity change** Contact: ali.karley@hutton.ac.uk
The statistical analysis of flying aphids data from the Dundee suction trap (over seven decades) has shown a shift in aphid diversity in the past ~2 decades which correlates with increased temperatures and changes in specific land uses. The analyses are being extended to long-term datasets from the other Scottish suction traps. Initial findings were presented at the Ento' 24 conference in September.
- 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
The water and salmon samples from River Dee have been collected for the analysis of endocrine disrupting compounds. The River Dee Trust have agreed to help sampling particularly for the salmon samples collection. Sampling campaign for the EDCs monitoring in the water and salmon from River Dee will continue into year 4.
- 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
We carried out eight interviews between 9th August and 6th September 2024 over Webex to estimate costs of INNS in heath and moorland. Interviewees included representatives from NatureScot (overarching INNS experts and individual site managers), Scottish Government, Heather Trust, Joint Nature Conservation Committee (JNCC), Scottish Land and Estates, and Scottish Deer Management Group. 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.



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 policies 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 and 2023 samples were collected from alpine grassland, dwarf-shrub heath and moss heaths on 170 Munros. 2024 is our final year of sample collection and with just a couple of weeks to go, we have now received samples from 249 summits. DNA has been extracted and sequenced from the 510 samples collected by the end of 2023 and the remaining samples collected during 2024 will be sequenced this autumn. 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. Once complete, this dataset will reveal the scale of the biodiversity associated with Scotland's mountain soils, and our analysis will focus on determining how soil biodiversity varies across Scotland in relation to factors including rainfall, temperature, elevation, geology and nitrogen deposition.
- 4. Monitoring approaches for outcomes focused interventions** Contact: cathy.hawes@hutton.ac.uk
Work is ongoing to develop the Bio4Ag toolbox designed to facilitate the transition towards biodiversity based cropping systems. Bio4Ag will be an open access, online, interactive resource library and data repository, combined with a predictive qualitative model that guides users (primarily growers and land managers) through the iterative process of cropping system design, implementation and monitoring for enhanced biodiversity and soil health. User friendly monitoring protocols for use by non-experts have been developed and tested at the CSC platform and refined in collaboration with NatureScot through POBAS and the Biodiversity Audit to create a handbook for in-field biodiversity and soil health assessment. Results from this outcomes-based approach can be used to refine the suite of management options further, resulting in a bespoke design tailored to the specific conditions of a given farm business.



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 policies 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 maximizing multiple social and ecological benefits from woodland restorations 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.



Recent highlights and outputs:

- Fielding, et al. 2024. Limited spatial co-occurrence of wildfire and prescribed burning on moorlands in Scotland. *Biological Conservation*, 296, p.110700
<https://doi.org/10.1016/j.biocon.2024.110700>
- 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

Regeneration and expansion of woodland habitats are integral to addressing both the climate and biodiversity crises. The project focuses on how we can maximise the multiple benefits which can be accrued from woodland schemes. Our integrated approach has combined geo-spatial data analysis, participatory community-based assessment and socio-biophysical integrated modelling to analyse 30+ years of woodland expansion activities in Scotland. There is a particular focus on the equity of the distribution of the benefits of woodland creation by linking support for thriving communities local to created woodlands (whether in urban or rural areas) that can share in the benefits of the nature based solutions such woodlands can provide whether they offer effective carbon sequestration, recreational or cultural services, or economic/livelihood gains for local people. Current fieldwork is currently focused on woodland creation in the urban context in Edinburgh.

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

Muirburn, which involves burning ericaceous and grass heathland areas, is used extensively as a management tool for regenerating new growth. However, concerns over the impacts of Muirburn have generated interest in alternative mechanical approaches for regenerating heathlands. Field experiments have been carried out at JHIs upland farm at Glensaugh and in collaboration with the RSPB at Abernethy in the CNP. Traditional muirburn was compared with two forms of mechanical cutting (brush cutting and robocutting). Analysis of soil nutrient probes indicate little difference in soil available nutrients between treatments, while brush cutting resulted the lowest impact on carbon loss and plant litter carbon losses compared to muirburn and robocutting. However, cutting treatments increase fine litter debris and it remains unknown whether this could influence future wildfire risk, and this needs further research. In addition, the response and recovery of soil biodiversity after muirburn and mechanical cutting needs to be determined.

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

Contact: andy.taylor@hutton.ac.uk

The proposed and ongoing expansion of Scotland's Atlantic rainforest includes the restoration of commercial conifer plantations that were established within existing ancient oakwoods (PAWS). While there is some existing knowledge on the impacts on biodiversity aboveground, there is no evidence base on impacts belowground from either PAWS creation or the ongoing management of removing the conifers in attempts to reestablish the former oakwoods. In addition, there are virtually no data from woodlands considered as 'pristine' oakwoods which would act as the end point targets for any restoration projects. In collaboration with FLS we carried out an intensive field study at Glen Creran near Oban, where we examined the impact of management on soil functional diversity in 42 plots arrayed across 6 different management areas. Overall, the soil biodiversity was massively impacted with each community easily distinguished between the different areas of management (see diagram below for fungal communities). The exception to this were the bacterial communities which were more strongly influenced by soil conditions than by management. These differences are translated to changes in nutrient availability and in decomposition processes potentially affecting carbon sequestration within the soil. Additional funds have been leveraged for a collaboration with FLS which supports the selection of other field sites and the compilation of studies involving belowground analyses.



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 policies 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 NatureScots 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, it is focusing on woodlands and working with NatureScot, FLS, FS and the Woodland Trust to discuss how monitoring of protected areas could be revised to move away from a feature based approach to monitoring ecosystem health.



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 redesigned the focus of this work package, this year responding to ongoing policy needs by focusing on the development of Other Effective Area-Based Conservation Measures policy in Scotland to reach our 30 x 30 targets. Moving forward this package will be working closely alongside the developments of OECM approaches in Scotland to understand how we can learn lessons from similar initiatives overseas, and pilot a place-based approach to support effective biodiversity conservation beyond formal designation in the future.
- 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 multisite common garden trial has highlighted the importance of the nursery environment which we have shown to have significant effects on growth, form, phenological and survival traits (paper submitted). We have also demonstrated that these effects can last up to 10 years post planting (paper submitted). Genotyping work to assess genetic diversity is nearing completion and we will carry out surveys of the pine fungal pathogen *Curreya* on our common garden sites this autumn, with help from Forest Research.
- 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
Microclimatic data has been analysed and predictive models have 98% success in reconstructing key climate parameters at 5 metre or smaller scales. This opens-up the possibility of identifying local climate change refugia nested within woodland protected sites. The next stage is quantifying the extent to which these refugia may persist or shift/disappear under climate change, representing the resilience of a site. The work is meeting prioritized knowledge gaps identified by members of the Alliance for Scotland's Rainforest, including: "How variable are UK rainforest microclimates?" and "Assess rainforest microclimates to inform spatial planning".
- 4. How do we measure the success of our protected areas?**
Contact: ruth.mitchell@hutton.ac.uk
This year we have been working with the Delivering Heathy Ecosystems Team in NatureScot and with FLS, FS and the Woodland Trust to devise an approach to Ecosystem Health monitoring in woodlands as part of a revision of the monitoring of protected areas. We have held four meetings so far and identified key drivers which we think should be monitored. We have discussed how the proposed new monitoring fits with existing monitoring in other organizations with the aim of not duplicating work. We are currently discussing how a resilience plan for woodlands might be developed so that the monitoring not only looks at current drivers of changes but assess future threats and how management can make a site more resilient to these threats.



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 policies 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:

- New technologies are also being assessed for detection of pathogens in water samples through EPIC (Scottish Government's Centre of Expertise for Animal Disease Outbreaks).
- The project team recently visited [Rif Field Station in Iceland](#) through funding from the UK – Iceland Arctic Science Partnership Scheme. eDNA approaches were piloted for environmental samples from several locations, including greylag geese breeding sites.
- Team members participated in the [OnFARM Podcast](#) focussing on Farming and AMR (antimicrobial resistance).

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 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* and molecular approaches are being used for speciation of both pathogens. DNA sequencing data is currently being generated to identify pathogen genotypes, which will be used to assess likelihood of transmission between cattle, calves and geese during years 3-5.

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 years 3-4, and 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: 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.



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

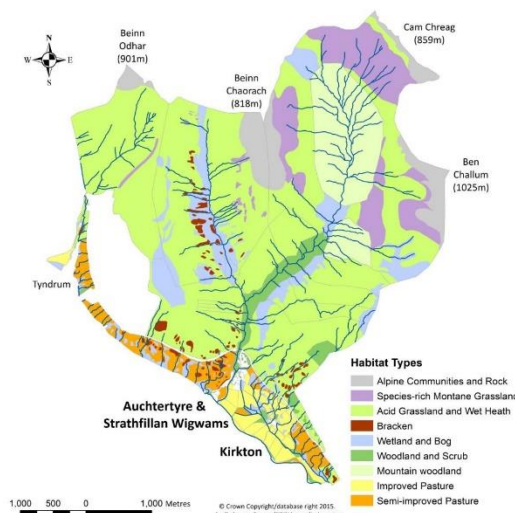


Key policies topics:

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. 2024. [Rewilding can be done in many small ways too](#). *Press & Journal*, 12th October 2024
- McCracken, D. 2024. Rewilding on productive farms. *Farm Advisory Service Video*, 9th October 2024
- McCracken, D. 2024. [Biodiversity studies must be robust and easy to carry out](#). *Press & Journal*, 20th July 2024

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

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. Work is ongoing to develop 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, with one online and one in-person meeting held at the farms in summer 2023. 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 very early discussions with colleagues at Loch Lomond & The Trossachs National Park as to whether it may be feasible to establish links with farms within their planned new Resilient Farm Network once it has been established



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.

Please see the links below for details about the projects within the Natural Capital Topic:

- Bringing in Participatory Approaches to widen the scope of natural capital valuation (JHI-D5-1; Simone.Martino@hutton.ac.uk - note change in leadership) <https://www.hutton.ac.uk/research/projects/bringing-participatory-approaches-widen-scope-natural-capital-valuation> [link down at time of writing but due to be restored]

- Climate change impacts on Natural Capital (JHI-D5-2; Mike.Rivington@hutton.ac.uk)
<https://www.hutton.ac.uk/research/projects/climate-change-impacts-natural-capital>
- Galvanising Change via Natural Capital (JHI-D5-3; Kerry.Waylen@hutton.ac.uk)
<https://www.hutton.ac.uk/research/projects/galvanising-change-natural-capital>
- Modelling the socio-economic, greenhouse gas and natural capital impacts of land use policy and opportunities (alistair.mcvittie@sruc.ac.uk)
<https://sefari.scot/research/projects/modelling-the-socio-economic-greenhouse-gas-and-natural-capital-impacts-of-land%20use-policy-and-opportunities-2>
- Synthesis of natural capital and valuation outcomes Alistair (alistair.mcvittie@sruc.ac.uk)
<https://sefari.scot/research/projects/synthesis-of-natural-capital-and-valuation-outcomes>
- Understanding the value of Scotland's agricultural soil natural capital (alistair.mcvittie@sruc.ac.uk) <https://sefari.scot/research/projects/understanding-the-value-of-scotland%E2%80%99s-agricultural-soil-natural-capital>

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

