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# ECOSYSTEMS AND LAND USE POLICY EXCHANGE GROUP (ELPEG) BULLETIN

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Issue 13, June 2021 (covering Nov 20 – Oct 21)

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**Photo:** Moving pine trees to a temperature-controlled facility to test late frost tolerance.

## What is this document?

The ELPEG Bulletin provides updates for policy stakeholders on research activities being undertaken within the Biodiversity and Ecosystems, and Integrated Natural Assets work packages of the Strategic Research Programme. The focus is the policy areas of:

- Scottish Biodiversity Strategy; Land Use Strategy for Scotland; Climate Change Plan and Climate Change Adaptation Programme; Scottish Rural Development Plan and CAP greening; Scottish Forestry Strategy.

This edition of the ELPEG Bulletin focuses on work where there has been, or will be, policy-related outputs and stakeholder engagement during the period November 2020 – October 2021. In the Bulletin we outline the work which we believe will be of direct interest to policy makers working in these areas. We also have an [ELPEG webpage](#)<sup>1</sup> where you can find past copies of the Bulletin.

The text below includes information on what has happened to date and what is planned up until October 2021. The researchers involved would welcome any queries, input and discussions concerning their work, and can be contacted directly via the e-mail addresses provided. Given the post 'Brexit' context, we would particularly welcome any insights and suggestions from you regarding how and when work may need to be adjusted to take account of changes in policy objectives and/or policy delivery mechanisms, including funding availability. **Please do get in touch with the person named for the area to find out more information.**

With the current Strategic Research ending in March 2021, we would welcome feedback on continuing with the bulletin and/or ELPEG meetings from 2022 onwards. Please send any feedback to [Holli.Hunter@hutton.ac.uk](mailto:Holli.Hunter@hutton.ac.uk).

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<sup>1</sup> <http://www.hutton.ac.uk/research/srp2016-21/elpeg-ecosystems-and-land-use-policy-engagement-group>

## ACRONYMS

AECS	Agri-Environmental Climate Scheme
AM	Adaptive Management
BTO	British Trust for Ornithology
CCAP	Climate Change Adaptation Programme
CCP	Climate Change Plan
CNPA	Cairngorms National Park Authority
CREW	Scotland's Centre of Expertise for Waters
ES/ESS	Ecosystem Services
ESCOM	Ecosystem Services Community Scotland
GIS	Geographical Information System
GWCT	Game & Wildlife Conservation Trust
H2020 MOVING	EU project on MOUNTAIN Valorisation through INterconnectedness and Green growth
H2020 PROVIDE	EU project on public goods and bads from agriculture and forestry in Scotland
JNCC	Joint Nature Conservation Committee
LLTNPA	Loch Lomond and The Trossachs National Park Authority
NFU	National Farmers Union
NGO	Non-Government Organisation
RSPB	Royal Society for the Protection of Birds
SASA	Science and Advice for Scottish Agriculture
SBS	Scottish Biodiversity Strategy
SFS	Scottish Forestry Strategy
SG	Scottish Government
SLE	Scottish Land & Estates
SQPV	Squirrel pox virus
SRDP	Scottish Rural Development Programme
SRP	Strategic Research Programme
SWT	Scottish Wildlife Trust

## SUMMARY OF POLICY-RELEVANT OUTPUTS

Expected delivery dates are included. As well as specific outputs mentioned, the research will also be discussed with the key policy contacts listed.

Topic	Contact	Policy contacts	Activities	Outputs
<b>Scottish Biodiversity Strategy</b>				
<a href="#">Diversity effects on ecosystem function &amp; resilience</a> (1.3.1, O1.1a).	<a href="mailto:Alison.Karley@hutton.ac.uk">Alison.Karley@hutton.ac.uk</a>	Cecile Smith (NatureScot), Jacqueline Hughes and Fiona Highet (SASA), David Michie (Soil Association Scotland).	Established a network of farm sites for testing diverse crop mixtures.	Innovative Farmers Intercropping Field Lab <b>(Nov 2020)</b> .
<a href="#">Agronomy and nutrition of bere barley</a> (1.3.1, O1.2b).	<a href="mailto:Tim.George@hutton.ac.uk">Tim.George@hutton.ac.uk</a>	Denise A'Hara (SASA), Susie Turpie (SG).	Work to unravel the genetic control of Bere traits.	SEFARI Event and video podcast produced, available on the SEFARI website.
<a href="#">Impacts of genetic factors on reintroduction success of threatened plants</a> (1.3.1, O1.2a).	<a href="mailto:A.Finger@rbge.ac.uk">A.Finger@rbge.ac.uk</a>	Iain Macdonald, Mike Smedley (NatureScot), David Hetherington (CNPA).	Testing drought resistance of <i>Woodsia ilvensis</i> .	Report <b>(Mar 2022)</b> .
<a href="#">Impact of management regimes on biodiversity, ecosystem function and ecosystem service delivery</a> (1.3.1, O1.3a).	<a href="mailto:Robin.Pakeman@hutton.ac.uk">Robin.Pakeman@hutton.ac.uk</a>	Des Thompson (NatureScot), Hamish Thompson (Woodland Trust), Alan Bell (LLTNPA).	Linkages between plant digestibility/palatability, invertebrate species composition and bird foraging <b>(Mar 2022)</b> .	<a href="#">SEFARI case study</a>

<a href="#">Connectivity metrics for temperate rainforest systems</a> (1.3.1, O3.3).	<a href="mailto:C.Ellis@rbge.ac.uk">C.Ellis@rbge.ac.uk</a>	David Genny, Jeanette Hall (NatureScot), Verity Brosnan (FR), Atlantic Woodland Alliance.	Two papers published on using landscape topography to create climate resilient microrefugia during forest restoration/connectivity ( <b>Jan 2021</b> ).	Training booklet on habitat structure/connectivity prepared for forest practitioners, in collaboration with Forest Research ( <b>Mar 2021</b> ).
<a href="#">Animal diseases – squirrel pox virus</a> (1.3.3, O3.2b).	<a href="mailto:Colin.McInnes@moredun.ac.uk">Colin.McInnes@moredun.ac.uk</a>	Scottish Squirrel Group, Scottish Wildlife Trust.	Tracking progression of SQPV ( <b>Mar 2021</b> ).	Data and advice on SQPV provided direct to stakeholders ( <b>Mar 2021</b> ).
<a href="#">Animal diseases – liver fluke</a> (1.3.3, O3.2a).	<a href="mailto:Philip.Skuce@moredun.ac.uk">Philip.Skuce@moredun.ac.uk</a>	Suzanne McIntyre (NatureScot, Nia Ball (SG AH&W).	Liver fluke risk and conservation grazing.	SEFARI case study on <a href="#">liver fluke risk to livestock</a> .
<a href="#">System – including ecosystem – resilience: identifying gaps in knowledge for Scotland’s biodiversity and ecosystems</a> (1.3.3, O1.1/3).	<a href="mailto:Ruth.Mitchell@hutton.ac.uk">Ruth.Mitchell@hutton.ac.uk</a>	Duncan Stone, Jeanette Hall (NatureScot).	Assess impact of multiple tree diseases on woodland biodiversity and whether a diversity of tree species provides resilience.	SEFARI case study: <a href="#">Ecological Resilience – woodlands and tree pests/pathogens</a> .
<a href="#">Response of Scots pine provenances to climate-driven weather events</a> (1.3.3, O2.1).	<a href="mailto:Jenni.Stockan@hutton.ac.uk">Jenni.Stockan@hutton.ac.uk</a>	Colin Edwards, Bob Frost (Scottish Forestry), Mike Perks (Forest Research).	Results from experimental work communicated to stakeholders ( <b>Feb 2022</b> ).	Pilot study report on effects of drought on pine trees, available on request.
<a href="#">Consequences of environmental and climate change for ecosystem resilience</a> (1.3.3, O2.2b).	<a href="mailto:Scott.Newey@hutton.ac.uk">Scott.Newey@hutton.ac.uk</a>	Rob Raynor (NatureScot), Adam Smith, Ross MacLeod (GWCT)	Assess the likely effects of woodland expansion on the distribution of mountain hare habitat ( <b>Sep 2021</b> ). We will use aerial imagery to complete mapping the distribution of muirburn across Scotland and	Complete the write-up of habitat-species distribution model of mountain hares in CNP and research summary ( <b>Mar 2022</b> ).

			use this to explore the distribution of key species in relation to this management activity ( <b>Mar 2022</b> ).	
<a href="#">Test cases to examine feasibility of offsetting for woodlands</a> (1.3.1, O3.3).	<a href="mailto:C.Ellis@rbge.ac.uk">C.Ellis@rbge.ac.uk</a>	David Genny, Jeanette Hall (NatureScot), Atlantic Woodland Alliance.	Paper and accompanying report being prepared for publication ( <b>Dec 2021</b> ).	
<b>Land Use Strategy</b>				
<a href="#">Assessment of habitat/species distributions and impacts of habitat loss and gain</a> (O1.4.2diii)	<a href="mailto:Alistair.Mcvittie@sruc.ac.uk">Alistair.Mcvittie@sruc.ac.uk</a>	John Uttley and Mareike Moeller-Holtkamp (NatureScot).	Further applications of biodiversity and ecosystem service net gain metrics ( <b>Mar 2021</b> ).	Case study report on SSEN sub-station development ( <b>Mar 2021</b> ).
<a href="#">Natural Asset Register: Data Portal</a> (1.4.1, Oa).	<a href="mailto:David.Donnelly@hutton.ac.uk">David.Donnelly@hutton.ac.uk</a>	CREW, NatureScot.	Continue to improve the guidance to users and the usability of the site ( <b>Dec 2020</b> ); Expand data sets as they become available ( <b>Mar 2021</b> ).	Natural Asset Register website ( <b>Mar 2021</b> ). Report on <a href="#">creating the data portal</a> ( <b>Mar 2021</b> ).
<a href="#">Cultural Ecosystem Services</a> (1.4.1, WP4).	<a href="mailto:Katherine.Irvine@hutton.ac.uk">Katherine.Irvine@hutton.ac.uk</a>	Pete Rawcliffe (NatureScot)	Developing integrative methods for mapping cultural ecosystem services.	SEFARI Case Study on <a href="#">principles for making green infrastructure socially inclusive</a> .  Digital stories on Sense of Place values and cultural ecosystem services (see A Story Tour of Glentool (arcgis.com)).

				<p>Paper on <a href="#">green infrastructure and social inclusivity</a>.</p> <p>Report to stakeholders in Galloway and Southern Ayrshire Biosphere Reserve on 'favourite places' (available upon request).</p>
<p><a href="#">Learning from application of natural capital accounting to land-based businesses</a> (1.4.2, Obi).</p>	<p><a href="mailto:Kirsty.Blackstock@hutton.ac.uk">Kirsty.Blackstock@hutton.ac.uk</a></p>	<p>Scottish Forum on Natural Capital (Rory McLeod) NatureScot (Mary Christie), Scottish Government (Ross Johnston), SLE (Stephen Young).</p>	<p>Analysis of existing literatures on land managers and climate change completed.</p> <p>Workshop on resilience and vulnerability of Scottish mountain natural assets (with H2020 MOVING) <b>September 2021</b>.</p> <p>Assessment of forest and water interactions for policy design (<b>Spring 2021</b>).</p>	<p>Briefing on land manager behaviours in response to climate change (<b>May 2021</b>).</p> <p>Report on Vulnerability assessment across EU mountains <b>Spring 2022</b>.</p> <p>Published outputs on accounting frameworks can be found <a href="#">here</a><sup>2</sup></p>
<p><a href="#">Opportunities to increase multiple benefits through public-private partnerships</a> (1.4.2, Obi)</p>	<p><a href="mailto:Kirsty.Blackstock@hutton.ac.uk">Kirsty.Blackstock@hutton.ac.uk</a></p>	<p>SEPA (Nicola Melville) Scottish Government (Alice Hunter) Anna Brand (SPiCE).</p>	<p>Analysis of partnerships to deliver multiple benefits (in conjunction with 1.2.4) being used to support Pilot Regional Land Use Partnerships <b>June 2021</b>.</p>	<p>Published outputs can be found on our <a href="#">website</a><sup>3</sup>; partnership report and briefing available now</p> <p>Internal confidential report for RLUPs <b>July 2021</b>.</p>

<sup>2</sup> <https://www.hutton.ac.uk/research/projects/integrating-natural-capital-thinking-land-based-decision-making>

<sup>3</sup> <https://www.hutton.ac.uk/research/projects/analysing-how-policy-instruments-shape-soil-water-and-biodiversity>

				Further webinar planned in <b>autumn 2021</b> .
<a href="#">Individual-based connectivity analysis tool</a> (1.4.2, Ocii – new14).	<a href="mailto:Marie.Castellazzi@hutton.ac.uk">Marie.Castellazzi@hutton.ac.uk</a>	Debbie Basset; Brian Eardley (NatureScot).	Assess connectivity over large areas.	Movement simulator to answer questions about connectivity between habitat patches ( <b>Mar 2022</b> ).
<a href="#">Low emissions land use change scenarios for woodland expansion for multiple benefits using SLM-OT tool</a> (1.4.2, Ocii - new14).	<a href="mailto:Alessandro.Gimona@hutton.ac.uk">Alessandro.Gimona@hutton.ac.uk</a> ; <a href="mailto:Marie.Castellazzi@hutton.ac.uk">Marie.Castellazzi@hutton.ac.uk</a>	Mary Christie (NatureScot); Peter Phillips (Scot Gov)	Create and assess land use scenarios in Scotland.	Highlight areas where land use change (including woodland expansion) would be beneficial to reduce potential emissions from land ( <b>Mar 2022</b> ).
<a href="#">Recommendations for landscape-level adaptive management for ecological, economic, and social outcomes</a> (1.4.3, Oa).	<a href="mailto:Kit.Nacleod@hutton.ac.uk">Kit.Nacleod@hutton.ac.uk</a>	SEPA, NatureScot	Fourteen specific recommendations from five studies.	<a href="#">SEFARI case study</a>
<b>Climate Change Plan and Climate Change Adaptation Programme</b>				
<a href="#">Response of key pest species to climate change</a> (1.3.3, O2.2a).	<a href="mailto:Lucy.Gilbert@glasgow.ac.uk">Lucy.Gilbert@glasgow.ac.uk</a>	Roger Evans (NHS), Dominic Mellor (RESAS), Nia Ball (CNPA), Nia Ball (SG), Adam Smith (GWCT), Ian Francis (RSPB).	Major synthesis on the impact of climate change on different ticks and tick-borne diseases globally.	Major publication: Gilbert, L (2021) The impacts of climate change on ticks and tick-borne disease risk. <i>Annual Review of Entomology</i> 66, 373-388. <a href="https://doi.org/10.1146/annurev-ento-052720-094533">https://doi.org/10.1146/annurev-ento-052720-094533</a> ( <b>Feb 2021</b> ).



<a href="#">Peatland restoration</a> (1.3.3, O2.2c).	<a href="mailto:Rebekka.Artz@hutton.ac.uk">Rebekka.Artz@hutton.ac.uk</a>	Johan Schulten, Claire Campbell (SEPA), Andrew McBride and Andrew Coupar (NatureScot), Russell Anderson, Mike Perks (Forest Research), Neil Cowie, Mark Hancock, Jeremy Wilson (RSPB), Zoe Frogbrook (Scottish Water).		Policy note distributed to stakeholders and available on request ( <b>May 2020</b> ).
<b>SRDP and CAP greening</b>				
<a href="#">New management options for agri-environment schemes</a> (1.3.1, O4).	<a href="mailto:Robin.Pakeman@hutton.ac.uk">Robin.Pakeman@hutton.ac.uk</a>	Maria de la Torre (NatureScot), Hugh Dignon (SG)	Survey of new experimental investigation delayed from 2020 ( <b>Mar 2022</b> ).	
<a href="#">Impact of liming</a> (1.3.1, O1.3b).	<a href="mailto:Scott.Newey@hutton.ac.uk">Scott.Newey@hutton.ac.uk</a>	Jessica Findlay, Alastair MacGugan (NatureScot), Adam Smith (GWCT), Chris Wernham (BTO), Duncan Orr-Ewing (RSPB), Karen Ramoo (SLE).	Analyse and write up study of the effects of lime addition ( <b>Mar 2021</b> ).	Research summary on <a href="#">affects of liming on biodiversity and ecosystem function</a> . SEFARI case study (pending upload).
<a href="#">Implementation of agri-environment schemes at a landscape scale to deliver multiple benefits and protect natural assets</a> (1.4.3, Ob).	<a href="mailto:Laure.Kuhfuss@hutton.ac.uk">Laure.Kuhfuss@hutton.ac.uk</a>	Kirsten Brewster, Ross Lilley (NatureScot)	Desk-based comparative study of existing Result-Based Payment Schemes implemented with groups of farmers for the provision of environmental	Research Brief distributed to stakeholders and available on request. SEFARI case study will be prepared ( <b>July 2021</b> )

			benefits at the landscape scale (March 2021).	
<b>Scottish Forestry Strategy</b>				
<a href="#">Human-environment interactions in the supply of ecosystem services</a> (1.3.2, O1.3).	<a href="mailto:Antonia.Eastwood@hutton.ac.uk">Antonia.Eastwood@hutton.ac.uk</a>	Louise Sing, Duncan Ray, Bob Frost, Sasha Laing (Scottish Forestry), Dougie Peedle (SWT), Louise Bond, Nicola Melville (SEPA), Jessica Maxwell (Woodland Trust)	Training in digital story telling provided to SWT so they can capture stories of impact and benefits from human-nature interaction. Developed scenarios for two Loch Arkaig sites (Woodland Trust and Community Woodland). Expert panel workshops for Loch Arkaig planned for August 2021.	
<a href="#">Woodland management and digital storytelling</a> (1.4.3, Oc).	<a href="mailto:Katrina.Brown@hutton.ac.uk">Katrina.Brown@hutton.ac.uk</a> <a href="mailto:Antonia.Eastwood@hutton.ac.uk">Antonia.Eastwood@hutton.ac.uk</a>	Arthur Keller and Ivan Clarke at NatureScot. Will Boyd-Wallis, Andy Ford (CNPA).		<a href="#">Research brief</a> on factors that enable adaptive management in urban areas.
<a href="#">Impacts of tree pests and diseases - risk assessment for service provision</a> (1.3.3, O3.1a).	<a href="mailto:Ruth.Mitchell@hutton.ac.uk">Ruth.Mitchell@hutton.ac.uk</a>	Duncan Stone, Jeanette Hall (NatureScot)	Two SEFARI case studies and two peer review papers published.	<a href="#">SEFARI case study: Ecosystem resilience – woodland establishment on heather moorland and carbon budgets.</a> <a href="#">SEFARI case study: Ecological Resilience – woodlands and tree pests/pathogens.</a> <a href="#">Mitchell et al (2021) Identifying substitute host tree species for epiphytes:</a>

				<p><a href="#">The relative importance of tree size and species, bark and site characteristics. Applied vegetation science, DOI: 10.1111/avsc.12569</a></p> <p>Mitchell et al (2021) <a href="#">Functional and ecosystem service differences between tree species: implications for tree species replacement</a>. Trees Structure and Function, 35, 307-317. DOI 10.1007/s00468-020-02035-1</p>
<p><a href="#">Using social innovation to deliver multiple benefits in forestry</a> (1.4.2, Obiii).</p>	<p><a href="mailto:Maria.Nijnik@hutton.ac.uk">Maria.Nijnik@hutton.ac.uk</a></p>	<p>Bianca Ambrose-Oji (Forest Research), Richard Murray, Heather McCabe (SG), Matt Smith (JNCC) Andy Ford (CNPA), Marc Metzger (ESCOM).</p>	<p>Developed a framework to identify the role of social innovation for sustainability transformation.</p> <p>Explored Reconstructive Social Innovation Cycles in Women-Led Initiatives in Rural Areas.</p>	<p>Results published in refereed journals (<a href="#">Kluvankova et al. 2021</a>, <a href="#">Nijnik et al. 2020</a>, <a href="#">Barlagne et al. 2021</a>, <a href="#">Ravazzoli et al. 2021</a>, <a href="#">Sarkki et al. 2021</a>).</p> <p><i>Video presented</i> at the EU Rural Vision Week, Imagining the Future of Europe's Rural Areas (<b>22-26 Mar 2021</b>).</p>

## SCOTTISH BIODIVERSITY STRATEGY

This work is aimed at supporting delivery of the Scottish Biodiversity Strategy. It involves studies examining the ecology of keystone species of conservation concern, both native and non-native (including pests and diseases), as well as the relationships between biodiversity, people and the delivery of ecosystem services. It also includes work helping support delivery processes for the SBS, including for example the development of Ecosystem Health Indicators, or development of a National Ecological Network for Scotland.

The underlying **mechanisms linking biodiversity and ecosystem service delivery** are being explored through focussed experimental studies (1.3.1, O1.1a).

We have published a [research paper](#) based on our 2017 experimental studies. These show that the benefits of increasing cultivar diversity in terms of weed and disease suppression are maintained under drought conditions. However, the response of aphids to the combination of diversity and drought was much more complex, demonstrating that the benefits of biodiversity are not constant. In addition we published a [review paper](#) exploring the role of beneficial plant-plant interactions in driving biodiversity-ecosystem function effects in crop systems, discussing in

particular how improved ecological knowledge can help deliver future sustainable farming systems. We are now building on our established network of farm sites for testing diverse crop mixtures in commercial settings and will be using these as platforms for testing innovative open science approaches during year 6 of the SRP (**Dec 2021**; audience: SG, academics, land managers, policy; [Alison.Karley@hutton.ac.uk](mailto:Alison.Karley@hutton.ac.uk)).

Detailed studies continue to **examine the genetic resource available within traditional bere barley landraces**, including assessing the growth of different landraces under a range of environmental conditions and producing crosses between Bere barley and commercial cultivars to unravel the genetic control of useful traits (1.3.1, O1.2b). Research so far has shown that extant barley landraces selected over many generations on marginal soils have adapted to tolerate limited micronutrient availability and harbour some pathogen resistance. Field trials in 2018 demonstrated that there is significant variation in manganese efficiency in the progeny of a cross between Bere barley and an elite cultivar Irina and this was confirmed in an advanced cross population in 2020. In addition, a field trial in 2019 assessed the performance of Bere barley lines in comparison to the industry recommended list for spring barley. Information on the research was disseminated to industry at the Barley Away Days in Dunkeld in February 2020, this year the event was sponsored by

SEFARI, which allowed for a workshop with stakeholders to assess the needs of the industry which could be delivered by our knowledge of barley diversity. In 2020 we continued to unravel the genetic control of the unique Bere traits as work began on the genomics of the physiological mechanisms involved when an EU Marie Curie Fellowship building on the RESAS work, started in August. In 2021 this work will continue and we will extend our understanding to other marginal soils across Scotland. The culmination of the current programme of work will include the production of reports and a stakeholder event to be held in Orkney if restrictions allow. (**May 2021**; intended audience: SG, academics, land managers; [Tim.George@hutton.ac.uk](mailto:Tim.George@hutton.ac.uk)).

Understanding the **impacts of genetic factors on reintroduction success** is critical for the conservation of threatened plants and animals (1.3.1, O1.2a). We will continue to monitor the survival of germinating plants resulting from cross-pollination and monitor the survival of reintroduced plants. Furthermore, cameras installed at *Cicerbita alpina* reintroduction sites showed that black slugs (*Arion ater*) were the main grazers. Translocations across the four Botanic Gardens (Edinburgh, Dawyck, Benmore, Logan) tested the resilience of *Cicerbita alpina* to varying climates. Work in 2020 will test the drought resistance of *Woodsia ilvensis* and whether this can be linked to genetics or provenance (**Mar 2022**; audience: SG,

NatureScot, academics;  
[A.Finger@rbge.ac.uk](mailto:A.Finger@rbge.ac.uk)).



**Photo:** Scrub development at Glen Finglas.

The **impact of management regimes on biodiversity, ecosystem function and ecosystem service delivery** (1.3.1, O1.3a) are being examined in upland ecosystems. A [manuscript](#) has been published that shows that the mosaic of vegetation communities at Glen Finglas has been remarkably stable in terms of their functional characteristics despite the large shifts in management (including tripling numbers or complete removal of sheep). The work of the whole long-term project has been summarised in a [SEFARI case study](#). The focus of the work to investigate how management affects the linkages between plant digestibility/palatability, invertebrate

species composition and bird foraging has moved on to characterising the quality of plants and invertebrates as food (**Mar 2022**; audience: SG, NatureScot, academics; [Robin.Pakeman@hutton.ac.uk](mailto:Robin.Pakeman@hutton.ac.uk)).

**Connectivity metrics for temperate rainforest systems** (1.3.1, O3.3) have been used to identify spatial strategies for woodland regeneration that allow for the persistence of extant populations and gains in terms of the colonisation/establishment of new populations. We have extended this work to also consider how reforestation can use topographic variation (aspect, slopes, water courses etc.) to create microrefugia that offer species an increased resilience to future climate change. This has demonstrated the importance in spatial targeting of new woodland, to maximise the long-term gain for biodiversity. It is also shown how existing woodland, which is often simplified as a consequence of its past history, can be diversified to create relevant microrefugia (**Jan 2021**; audience: land managers; [C.Ellis@rbge.ac.uk](mailto:C.Ellis@rbge.ac.uk)).

**Animal diseases** play a regulatory role in, and can threaten, Scotland's natural environments. Work within the SRP (1.3.3, O3.2b) examines the role of squirrelpox virus (SQPV) in the replacement of native red squirrels by invasive grey squirrels. Researchers provide blood testing as required by SWT and other landowners to track the prevalence of squirrelpox virus in grey

squirrels and therefore the potential threat to red squirrels. Data and advice on the general problem of SQPV and recommendations for animal and disease management will be provided to appropriate stakeholders (**Mar 2022**; audience: SG, NGOs, agencies; [Colin.McInnes@moredun.ac.uk](mailto:Colin.McInnes@moredun.ac.uk)).

We continue to work with the local NatureScot Project team and the Wildfowl & Wetlands Trust, monitoring livestock grazing on selected saltmarsh (merse) habitat on the Solway Firth, home to Scotland's only breeding population of natterjack toads (1.3.3; 1.4.3). Conservation grazing is required to maintain the optimal habitat for toad feeding and breeding but brings with it a potential risk to the livestock from infection with liver fluke, which can cause significant health and production impacts in both sheep and cattle. There was a legacy of the hot dry summer of 2018, in that potential fluke intermediate host snails proved hard to find this season, but the New Zealand Mud Snail dominated. This species has been shown to harbour liver fluke stages, but those collected and analysed proved to be negative for fluke by DNA-based testing. We also progressed some lab-based pilot studies, which demonstrate that liver fluke and eggs did not hatch well in high salinity Solway water, suggesting the risk of snails becoming infected on the merse (saltmarsh), from fluke eggs deposited by infected livestock, is actually quite low. This work has been summarised in a [SEFARI case study](#) (**Mar 2021**; audience:

SG, agencies, NGOs, land managers, farmers; [Philip.Skuce@moredun.ac.uk](mailto:Philip.Skuce@moredun.ac.uk)).



**Photo:** Monitoring Scots pine trees following frosting treatments at Glensaugh.

The **resilience of ecosystem foundation tree species to environmental and climate change** and how this is affected by provenance and genotype (1.3.3, O2.1) is being investigated using native Scots pine trees in a long-term experiment. We have demonstrated that associated insect and fungi with pine trees is linked to provenance. A pilot study on the effect of summer drought showed differential responses in growth and mortality according to provenance. A large-scale late frost tolerance experiment was conducted in Mar 2021 and monitoring is ongoing to assess how trees of different provenances respond. Data from across

all five years of the SRP is being analysed to produce four research papers on the effects of provenance and genetic variation on the growth and phenology of Scots pine (**Feb 2022**, audience: agencies; [jenni.stockan@hutton.ac.uk](mailto:jenni.stockan@hutton.ac.uk)).

Research will continue to explore **the consequences of environmental and climate change for ecosystem resilience** (1.3.3, O2.2b) by focussing on the possible redistribution of high impact and umbrella vertebrate species. Mountain hares are a species of high conservation concern in Scotland. In collaboration with the GWCT we will complete the species distribution modelling to describe the distribution of mountain hares on mainland Scotland in relation to biophysical and land use characteristics, and explore how land use change, using wood land expansion as an example, may affect the distribution of mountain hares. (**Sep 2022**; audience: NatureScot, National Park Authorities, NGOs, agencies; [Scott.Newey@hutton.ac.uk](mailto:Scott.Newey@hutton.ac.uk)).

New research on grouse moor management is exploring the **extent, distribution and intensity of muirburn**. We will map the distribution of muirburn from aerial imagery and use this to explore the distribution of selection of species in relation to muirburn (**Mar 2022**; NatureScot, NGOs; [scott.newey@hutton.ac.uk](mailto:scott.newey@hutton.ac.uk)).

Research is developing specific **test cases to examine feasibility of offsetting for woodlands** (1.3.1, O3.3).

The focus habitat is upland oak woodland, and analysis has asked whether recently regenerated woodlands could be substituted for more ancient woodland? The preliminary results suggest that – in general – landscape context is the most important factor in determining woodland species composition and richness, with ancient and regenerated sites having similar composition/richness where they occur within the same watershed. However, there are clearly rare/threatened species that benefit from ecological continuity, and it is important to decide whether conservation strategy focuses on general principles, or the specific needs of the rare/threatened (or both). A paper and report are being prepared (**Dec 2021**; audience: SG and agencies, land managers; [C.Ellis@rbge.ac.uk](mailto:C.Ellis@rbge.ac.uk)).

## LAND USE STRATEGY FOR SCOTLAND

This research is designed to support the delivery of the Land Use Strategy 2016-21, including the vision, objectives, principles and particularly the policies 1, 2, 4, 6, 7, 8 and 9; and the proposals 1, 3 and 5.

James Hutton Institute response to Scottish Government **consultation** on Scotland's Land Use Strategy. *Published on Scottish Government Consultation Hub.*

A comprehensive report on the activities required to produce the **Natural Asset**

**Register: Data portal** (1.4.1a) has been produced. This report describes the decision processes and the various steps required to achieve successful implementation of the tool. The report also lists and includes links to the various outputs which were part of the project and reflects on what has been achieved and options for future funding (**Mar 2021**; intended audience: SG and agencies [David.Donnelly@hutton.ac.uk](mailto:David.Donnelly@hutton.ac.uk)).

As part of investigation of methods for **mapping cultural ecosystem services** (O1.4.1, WP4), interviews around sense of place were conducted with residents of the Galloway and Southern Ayrshire UNESCO Biosphere community of Glentworth. The interviews were filmed and edited to produce 2-7 minute digital stories. These stories were incorporated in an ArcGIS StoryMap capturing local knowledge about the history, landscape and special places in the area (see A Story Tour of Glentworth ([arcgis.com](http://arcgis.com))). A draft prototype map testing the applicability of methodology for ecological aspects of aesthetics as a cultural ecosystem service was published on the National Assets Register and a prototype spatially-explicit map of spiritual experiences is under development. Further work will compile insight on the novel methods utilised to map and understand the less tangible cultural ecosystem services (**Mar 2022**; intended audience: agencies and public; [Katherine.Irvine@hutton.ac.uk](mailto:Katherine.Irvine@hutton.ac.uk)).

Case studies of **Natural Capital Accounting** (1.4.1, Oc) initially focused



on agriculture and forests have been completed. These utilised primary valuation studies on forest recreation (pan European, with Scottish element funded by the SRP) and water quality and biodiversity impacts of agriculture (funded by H2020 PROVIDE). A case-study on urban green space has been completed. This utilised both existing valuation data and a primary valuation study covering biodiversity and recreation. Further in-depth analysis of the primary valuation data (report available) and how capabilities impact on greenspace use (paper in preparation) have also been completed. Regionally disaggregated marine natural capital accounts were also completed during year 5 (**Mar 2021**; intended audience: SG and agencies; [Alistair.McVittie@sruc.ac.uk](mailto:Alistair.McVittie@sruc.ac.uk)).

**Learning from application of natural capital accounting to land-based businesses** (O1.4.2bi). A review of land manager behaviour for climate action will be published (**May 2021**) (Intended audience: Scottish Forum for Natural Capital Sustainable Land Use working group; Scottish Government). Further work has been completed on distribution of natural capital ([working paper now available](#)), [Research](#) on opportunities to invest in natural capital (with MDT fellowship) is ongoing and a report is due in **July 2021**. [Kirsty.Blackstock@hutton.ac.uk](mailto:Kirsty.Blackstock@hutton.ac.uk).

An Institutional Analysis and Reconfiguration Framework with identification of the role of social

innovation for sustainability transformation was developed and tested (three [journal articles published](#)). Impacts of social innovation in the context of community forestry on the sustainable development of rural communities were assessed ([three journal articles published](#)) (1.4.2biii). Findings were e.g., that community forestry in Scotland leads to positive impacts in the environmental, social, economic and institutional/ governance domains. Specific impacts were increased community cohesion, sense of place and well-being, local employment opportunities. Reconstructive Social Innovation Cycles in Women-Led Initiatives in Rural Areas were explored ([journal article published](#)). The *marketplace stall on social innovation* in rural areas was organised, and Social innovation in marginalised rural areas *Video presented* at the EU Rural Vision Week, Imagining the Future of Europe's Rural Areas (**22-26 March 2021**) [Maria.Nijnik@hutton.ac.uk](mailto:Maria.Nijnik@hutton.ac.uk).

**Opportunities to increase multiple benefits through partnership working** (1.4.2bi). The findings from selected four case studies in Scotland and England to consider how catchment partnerships combine public policy and private sector mechanisms to deliver multiple benefits (in conjunction with WP 1.2.4) are now summarised in a final [report](#) and briefing. The insights are being used to support peer learning between the five pilot regional land use partnerships; and a further webinar and briefing is planned for **autumn 2021** (audience: SG,

agencies and NGOs;  
[Kirsty.Blackstock@hutton.ac.uk](mailto:Kirsty.Blackstock@hutton.ac.uk)).

**LEMMINGS, an Individual-based movement simulator**, has been created to assess habitat connectivity and applied to assess some of the consequences of land use change scenarios for the whole of Scotland (O1.4.2cii-new14). Analysis will continue throughout 2021 including further low emissions and Shared Socioeconomic Pathways scenarios (**Mar 2022**; audience: NGOs, agencies; [Marie.Castellazzi@hutton.ac.uk](mailto:Marie.Castellazzi@hutton.ac.uk)).

**Recommendations for landscape-level adaptive management for ecological, economic, and social outcomes.** We have made fourteen specific recommendations based on: understand the situation, direct stakeholders, and shared purpose; focus on the social relationships of landscape-level management; and assess ecological, economic, and social outcomes at every step of the adaptive management cycle. (**Oct 2020**; audience: SG and agencies; [Kit.Macleod@hutton.ac.uk](mailto:Kit.Macleod@hutton.ac.uk)).

## CLIMATE CHANGE PLAN & ADAPTATION PROGRAMME

This research addresses some of the major challenges arising from the CCP and CCAP, including understanding how climate-induced land-use change might

alter the delivery of climate-relevant ecosystem services such as soil carbon storage and forestry. It will also look ahead to support development of the next Scottish Climate Change Bill.

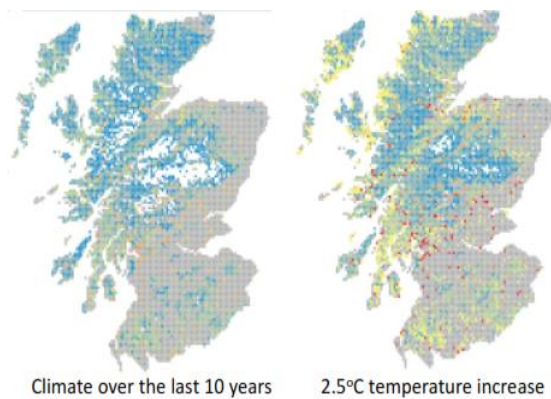
**A land use change scenario tool for multi-benefits** (SLM-OT tool - Sustainable Land-use Management Options Tool) has been created to facilitate the creation of scenarios for multiple Ecosystem Services (O1.4.2cii-new14) (**Mar 2021**). The tool will be used to develop further low emissions scenarios, particularly regarding to woodland expansion. They will then be assessed for potential emissions savings (**Mar 2022**; audience: NGOs, agencies; [Alessandro.Gimona@hutton.ac.uk](mailto:Alessandro.Gimona@hutton.ac.uk), [Marie.Castellazzi@hutton.ac.uk](mailto:Marie.Castellazzi@hutton.ac.uk)).



**Photo:** Tick nymphs.

To understand the **range shifts and resilience of key pest species to climate change** we developed models and risk maps to predict ticks and Lyme disease (the most prevalent vector-borne disease in the northern hemisphere) under climate and other environmental change scenarios (1.3.3, O2.2a) across Scotland and Europe (published in *Journal of the Royal Society Interface* and in *Environmental Health*

*Perspectives*) (Figure 1). We also published a major synthesis for the journal *Annual Review of Entomology* (Impact Factor 11.8) on the response and resilience of ticks and tick-borne diseases to climate change globally. Our next task is to synthesise how green recovery schemes may affect ticks and disease (audience: NatureScot, NHS, land-managers; [Lucy.Gilbert@glasgow.ac.uk](mailto:Lucy.Gilbert@glasgow.ac.uk).



**Figure 1.** Tick density predicted from models.

Peatland systems are a key component of the natural environment's contribution to climate change mitigation. We built a model of peatland restoration progress at a site in the Cairngorms (upland area at Balmoral Estate) based on Earth Observations from radar-based (Sentinel-1) and optical (Sentinel-2) imagery combined with terrain and aerial photography data. The model was good (0.745 accuracy) at detecting erosion/vegetation classes for recent years, but small areas of gully reprofiling were much harder to accurately detect than contiguous restoration management types such as felling activities. Results were presented

to the British Ecological Society conference in December. This work has produced four research papers (all *in press*) and a research note has been distributed to stakeholders (and is available more widely on request) (audience: SG and agencies/NGOs with an interest in peatland systems; **Mar 2020**), [Rebekka.Artz@hutton.ac.uk](mailto:Rebekka.Artz@hutton.ac.uk)).

Many projects listed under other headings include an aspect of climate change adaptation including: **understanding the role of biodiversity in delivering ecosystem resilience** (1.3.1, O1.1a); **woodland supply of ecosystem services** (1.3.2a); **adaptive management approach to facilitate the evaluation and coordination of measures to deliver multiple benefits** (1.4.3a); **assessing multiple land use options** (1.4.2cii)).

## SRDP AND CAP GREENING

This research is designed to support the implementation of the Scottish Rural Development Programme (2014-20) in particular, the implementation of the Agri-Environment Climate Scheme management and capital options and the Forestry Grant Scheme. However, research may also inform the implementation of Areas of Natural Constraint, beef efficiency scheme, and the advisory services plus we support and contribute to the Scottish Rural Network.

Using information from our assessment of gaps in the current agri-environment schemes we have developed an experimental study to assess a **new management option for agri-environment schemes** (1.3.4, O2). An experiment was established in spring 2018 to assess the long-term potential and cost-effectiveness of grassland sward diversification to improve foraging resources for pollinators and increase the digestibility of forage for livestock. This work will continue through into summer 2021 as sampling wasn't possible in 2020 (**Mar 2022**; intended audience: SG and agencies involved in AECS implementation; [Robin.Pakeman@hutton.ac.uk](mailto:Robin.Pakeman@hutton.ac.uk)).

Research into the **implementation of agri-environment schemes at a landscape scale to deliver multiple benefits and protect natural assets** (1.4.3b) has progressed with the monitoring of environmental benefits of 'magic-margins' that were implemented in collaboration with farmers on the Balruddery catchment in 2019, as well as on the socio-ecological modelling of the provision of Environmental Services by the lowland arable-grass catchment. However, rescheduling of the work to adjust to the constraints imposed by Covid-19 mean that the success of the establishment and the environmental performance of the magic margins' measure at Balruddery will be now assessed in 2021 - 2022. The investigation of potential agri-environmental scheme design and related payment to support the

coordination of farmers' provision of environmental benefits at the landscape scale has focussed on the potential of result-based payment schemes with a desk-based study of existing schemes across Europe. Results are presented in a research brief (**March 2021**) (audience: SG, NatureScot, land managers and advisors; [Laure.Kuhfuss@hutton.ac.uk](mailto:Laure.Kuhfuss@hutton.ac.uk)).

The new hydrological modelling finalised within the research on the solutions for the provision of **multiple benefits through innovative and collective approaches to water management** (1.4.3d) has supported an agreement between key stakeholders of the Lunan catchment management group on actions to be implemented to ensure the protection of biodiversity in local sensitive wetlands while managing the risks of flooding (**Mar 2021**). The next few months will be dedicated to the dissemination of key findings from this research project, with a stakeholder workshop scheduled in the autumn (**Dec 2021**) (audience: agencies, local authorities; [Laure.Kuhfuss@hutton.ac.uk](mailto:Laure.Kuhfuss@hutton.ac.uk)).

## SCOTTISH FORESTRY STRATEGY

This research aims to support the implementation of the Scottish Forestry Strategy, including the vision, objectives, outcomes and themes, particularly climate change, biodiversity, environmental quality, community

development and access and health. The research will also provide evidence, as requested for the SFS review (as highlighted in the Land Use Strategy and Programme for Government).

Woodland systems, including in urban areas, will continue to be the focus of work considering how management interventions (e.g. restoration, public engagement), and their effect on the relationship between people and the environment, can alter the co-production **of ecosystem services** (1.3.2, O1.3). We have completed two case-studies; Glen Creran and Cumbernauld. Workshop reports from the four stakeholder panel workshops exploring the changes in ecosystem services in response to land management, are available for stakeholder and policy audiences (intended audience: land managers, policy makers). We have secured the Woodland Trust and Loch Archaig Community Trust as partners for our third case study and plans are in place to conduct expert panel workshops (**Aug 21**). Staff from the Cumbernauld Living Landscape (Scottish Wildlife Trust have been trained (Dec 2020) in digital story telling methods which will enable them to capture impact stories of nature-engagement programmes. The research on citizen social science approaches to monitoring impacts of management interventions has been accepted for publication (**May 2021**), as has an article on the connecting young people with nature using participatory video (**May 2021**); audience: land managers and

policy makers;  
[Antonia.Eastwood@hutton.ac.uk](mailto:Antonia.Eastwood@hutton.ac.uk)).

**Changes in carbon storage following tree planting** (1.1.2) have been assessed on experimental plots on heather moorland where birch and Scots pine were planted 12 years ago and where birch were planted 38 years ago. Compared to the heather control plots carbon was lost from the soil where the trees were planted and the gain in above ground carbon (tree biomass) was either less than or only equalled the below-ground losses. Thus, on decadal timescales, tree planting on these organic rich soils, did not contribute to the meeting net zero carbon emissions target. The results are available as paper [here](#) and a SEFARI case study [here](#) (**May 2021**; audience: SG, agencies, land managers; [Ruth.Mitchell@hutton.ac.uk](mailto:Ruth.Mitchell@hutton.ac.uk)).

The **impacts of tree pests and diseases** are being considered. If a tree species declines due to disease, they are often replaced by different species. It is important to know how these replacement tree species will influence both ecosystem functioning and the biodiversity supported, i.e. how similar they are to the diseased tree species (1.3.3, O3.1a). Utilizing botanic gardens across the UK, each of which contained a range of tree species we assessed differences between tree species in their functioning and biodiversity supported. We found that tree species differed in their functioning (decomposition, nutrient cycling, soil properties) at the scale of an individual tree which will

result in differences in ecosystem service provision. Replacement trees for diseased trees should take account of functional differences, paper available [here](#). We also found that assessing similarities between tree species in their bark characteristics did not provide a good indication of the similarity in the lichen and bryophyte communities they supported, paper [here](#). Thus, the epiphytes hosted by a wider range of tree species should be recorded to allow an assessment of their suitability as replacement trees and hence aid management decisions on replacement trees following tree loss (**May 2020**; audience: SG, agencies, land managers; [Ruth.Mitchell@hutton.ac.uk](mailto:Ruth.Mitchell@hutton.ac.uk)).

Woodland management and digital storytelling (1.4.3, Oc). The prototype digital storymap featuring a multiplicity of video-based narratives and experiences relating to actual and potential woodland expansion in the Cairngorms National Park – enabling exploration of opportunities and barriers for meeting multiple land use objectives - has been prepared for testing through stakeholder workshops. A methodological approach for conducting the workshops has been drafted and meetings set up with key stakeholder representatives to receive feedback on both the storymap and the proposed approach for stakeholder engagement (**Dec 2021**; audience: agencies; [Katrina.Brown@hutton.ac.uk](mailto:Katrina.Brown@hutton.ac.uk)).

Approaches that reconcile **woodland expansion with other land use**

**priorities** (O1.4.3c). Qualitative interviews and social maps have been conducted with land managers in the Cairngorms National Park on adaptive management and woodland expansion. These have been analysed to provide a [research brief](#) and a journal paper on stakeholder roles and relationships in AM for realising multiple land use benefits (submitted to journal Mar 2020); audience: NGOs; stakeholders, policy makers. The research was expanded to include urban areas (Cumbernauld and Seven Lochs) as a comparison and has been written up into a research brief – [Enabling adaptive co-management of urban land: lessons from central Scotland](#) (**Mar 2021**). [Antonia.Eastwood@hutton.ac.uk](mailto:Antonia.Eastwood@hutton.ac.uk)).