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

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**Issue 12, October 2020 (covering Apr 20 – Mar 21)**

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**Photo:** Surveying ticks and their host in the western isles.

## 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. 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 April 2020 – March 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 2020. 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.**

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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 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
SNH	Scottish Natural Heritage
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 (SNH), 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.	
<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 (SNH), David Hetherington (CNPA).	Testing drought resistance of <i>Woodsia ilvensis</i> .	
<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 (SNH), Hamish Thompson (Woodland Trust), Alan Bell (LLTNPA).	Linkages between plant digestibility/palatability, invertebrate species composition and bird foraging ( <b>Mar 2021</b> ).	
<a href="#">Ecosystem Health Indicators</a> (1.3.1, O2.1) & Natural Capital Asset Index (1.4.1, Obiii).	<a href="mailto:Rob.Brooker@hutton.ac.uk">Rob.Brooker@hutton.ac.uk</a>	Tom McKenna, David O'Brien (SNH).		Risk assessment framework for environmental monitoring datasets ( <b>Feb 2021</b> ).

<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 (SNH), Atlantic Woodland Alliance.	Preparation of a seminar on spatial planning for forest restoration, to be delivered to Scotland's Atlantic Rainforest Alliance ( <b>Oct 2020</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 (SNH), Nia Ball (SG AH&W).	Liver fluke risk and conservation grazing.	
<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 (SNH).	Assess impact of multiple tree diseases on woodland biodiversity and whether a diversity of tree species provides resilience.	
<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 2021</b> ).	Research summaries ( <b>Feb 2021</b> ).
<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 (SNH), Adam Smith, Ross MacLeod (GWCT)	Assess the likely effects of woodland expansion on the distribution of mountain hare habitat ( <b>Mar 2021</b> ).	based habitat-species distribution model of mountain hares in CNP ( <b>Mar 2021</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>		Completed analysis of datasets ( <b>Dec 2020</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 (SNH).	Developing marine natural capital accounts ( <b>Mar 2021</b> ).	
<a href="#">Natural Asset Register: Data Portal</a> (1.4.1, Oa).	<a href="mailto:David.Donnely@hutton.ac.uk">David.Donnely@hutton.ac.uk</a>	CREW, SNH.	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> ).
<a href="#">Learning from application of natural capital accounting to land-based businesses</a> (1.4.2, Obi).	<a href="mailto:Kirsty.Blackstock@hutton.ac.uk">Kirsty.Blackstock@hutton.ac.uk</a>	Scottish Forum on Natural Capital (Rory McLeod) NatureScot (Mary Christie), Scottish Government (Ross Lilley), SLE (Eleanor Kay)	Analysis of existing reports supplemented with interviews across 5 cases in Scotland ( <b>Mar 2021</b> ).	Briefing ( <b>Nov 2020</b> ).
<a href="#">Opportunities to increase multiple benefits through public-private partnerships</a> (1.4.2, Obi)	<a href="mailto:Kirsty.Blackstock@hutton.ac.uk">Kirsty.Blackstock@hutton.ac.uk</a>	SEPA (Roy Richardson, Nicola Melville) Scottish Government (Fiona Harrison) Scottish Water (Mark Williamson), Matt Smith (JNCC), Anna Brand (SPiCE).	Analysis of four catchment partnerships that combine public policy and private sector mechanisms to deliver multiple benefits (in conjunction 1.2.4 <b>Jan 2021</b> ).	Published outputs can be found on our <a href="#">website</a> <sup>2</sup> ; report/stakeholder KE from <b>Feb 2021</b> .
<a href="#">Support Post-EU agricultural and environmental policy</a>	<a href="mailto:Kirsty.Blackstock@hutton.ac.uk">Kirsty.Blackstock@hutton.ac.uk</a>	Scottish Land Commission (Harriet Donald, Emma Cooper)	Provision of tailored evidence to SLC to support provision of advice to Ministers on setting up Regional Land Use Partnerships.	Briefings have been provided, and follow up seminar will be held ( <b>Nov 2020</b> ).

<sup>2</sup> <https://www.hutton.ac.uk/research/projects/analysing-how-policy-instruments-shape-soil-water-and-biodiversity>

<a href="#">evidence and analysis needs</a> (1.4.2, Obii)				
<a href="#">Individual-based connectivity analysis tool</a> (1.4.2, Ocii).	<a href="mailto:Marie.Castellazzi@hutton.ac.uk">Marie.Castellazzi@hutton.ac.uk</a>	Debbie Basset; Brian Eardley (SNH).	Assess connectivity over large areas.	Movement simulator to answer questions about connectivity between habitat patches ( <b>Mar 2021</b> ).
<a href="#">Recommendations for landscape-level adaptive management for ecological, economic, and social outcomes</a> (1.4.3, Oa).	<a href="mailto:Kit.macleod@hutton.ac.uk">Kit.macleod@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.	Literature review and a policy brief ( <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 (SNH), Russell Anderson, Mike Perks (Forest Research), Neil Cowie, Mark Hancock, Jeremy Wilson (RSPB), Zoe		Policy note distributed to stakeholders and available on request ( <b>May 2020</b> ).

		Frogbrook (Scottish Water)		
<b>Scottish Rural Development Plan &amp; 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 (SNH), Hugh Dignon (SG)	Establishment of new experimental investigation(s) ( <b>Mar 2021</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 (SNH), 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> ).	
<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>	NFU	Success of establishment and first environmental assessment, results discussed directly with stakeholders ( <b>Mar 2021</b> ).	
<a href="#">Innovative and collective approaches to water management</a> (1.4.3, Od)	<a href="mailto:Andy.Vinten@hutton.ac.uk">Andy.Vinten@hutton.ac.uk</a>	Ian Spiers, Joyce Carr (SG), Brian McCreddie, Richard Gosling, Stuart McGowan (SEPA), Peter McPhail, Deborah Spray (SNH)	Comparative analysis with Loch Leven catchment area ( <b>Apr 2020</b> ).	



## Scottish Forestry Strategy

<p><a href="#">Human-environment interactions in the supply of ecosystem services</a> (1.3.2, O1.3).</p>	<p><a href="mailto:Antonia.Eastwood@hutton.ac.uk">Antonia.Eastwood@hutton.ac.uk</a></p>	<p>David Hetherington, Hamish Trench, Andy Ford (CNPA), Louise Sing, Duncan Ray, Bob Frost, Sasha Laing (Scottish Forestry), Dougie Peedle (SWT), Louise Bond, Nicola Melville (SEPA).</p>	<p>Manuscript on using participatory video to engage people with local greenspaces.</p>	<p>Journal Article in People and Nature (<b>Mar 2021</b>).</p>
<p><a href="#">Development of a user-friendly tool for visualising woodland expansion through stereo-panorama Images</a> (1.4.2, Ocii).</p>	<p><a href="mailto:Chen.Wang@hutton.ac.uk">Chen.Wang@hutton.ac.uk</a></p>	<p>Bob Frost (Scottish Forestry), Will Boyd-Wallis, Andy Ford (CNPA).</p>	<p>Results from woodland expansion scenarios presented at EGU2020: Sharing Geoscience Online (<b>May 2020</b>).</p>	
<p><a href="#">Impacts of tree pests and diseases - risk assessment for service provision</a> (1.3.3, O3.1a).</p>	<p><a href="mailto:Ruth.Mitchell@hutton.ac.uk">Ruth.Mitchell@hutton.ac.uk</a></p>	<p>Duncan Stone, Jeanette Hall (SNH)</p>		<p>Forest Research Note (in press).</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>Knowledge advance &amp; exchange through a series of scientific manuscripts on social innovation to deliver multiple benefits prepared &amp; events held (<b>Oct 2020</b>).</p>	<p>Results published in refereed journals (<a href="#">Nijnik et al., 2019</a>; <a href="#">Metzger et al., 2019</a>; <a href="#">Sarkki et al., 2019a</a>; <a href="#">Kluvánková et al., 2019</a>; <a href="#">Secco et al., 2019</a>; van <a href="#">Kooten et al., 2019</a>; <a href="#">Sarkki et al., 2019b</a>; <a href="#">Vercher et al., 2020</a> &amp; e.g. a session at the ESG virtual event (<a href="#">Sept 2020</a>))</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 [SEFARI Gateway Case Study](#) summarising results from our 2016 and 2017 experimental studies. These show the potential win-wins of increasing biodiversity in crop systems. Further analysis of data from our 2017 experiment revealed some of the **mechanisms behind diversity-function relations**. For example, increasing the diversity of barley genotypes altered the expression of weed traits and reduced their ability to compete for resources. A field study was conducted in 2019 to test whether benefits in diverse vegetation depend on greater diversity of plant traits which could minimise plant-plant competition and improve complementary resource use. We

[published modelling work](#) which revealed a **novel mechanism explaining how diversity could be maintained** within insect herbivore populations, by variation in natural enemy efficiency when attacking rarely- or commonly-encountered prey. In 2020, we have established a network of farm sites for testing diverse crop mixtures in commercial settings and we discussed the practicalities of growing crop mixtures with stakeholders at the [Innovative Farmers Intercropping Field Lab](#) hosted by the Organic Research Centre (**Nov 2020**; 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. 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, this will inform the strategy for isolation of this useful trait for sustainability from Bere. 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 Cereals in Lincolnshire in July 2019, to policy makers through the ELPEG meeting in Edinburgh in

May 2019 and to a range of other stakeholders at the Sustainable Agriculture and Food Systems Summit in Berlin, September 2019 and the Barley Away Days in Dunkeld in February 2020. In 2020 we will continue to unravel the genetic control of the unique Bere traits in advanced progeny of the crosses grown in the field in Orkney and work will begin on the physiological mechanisms involved when a EU Marie Curie Fellowship building on the RESAS work, starts in August (**Jun 2020**; intended audience: SG, academics, land managers; [Tim.George@hutton.ac.uk](mailto:Tim.George@hutton.ac.uk)).



**Photo:** *Cicerbita alpina* flower.

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 (**Oct 2020**; audience: SG, SNH, academics; [A.Finger@rbge.ac.uk](mailto:A.Finger@rbge.ac.uk)).



**Photo:** *Woodsia ilvensis*.

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 accepted 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 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 2021**; audience: SG, SNH, academics; [Robin.Pakeman@hutton.ac.uk](mailto:Robin.Pakeman@hutton.ac.uk)).

The development and exploration of environmental monitoring indicators continues through work in the Strategic Research Programme (SRP), and collaboration between SRP researchers and key stakeholders (e.g. SNH staff). Work in 2020-2021 has been defined through

discussions with SNH colleagues and will focus on two key topics. First, we will explore whether it is possible to use existing long-term botanical monitoring data to assess the impacts of IPBES drivers in Scottish environments. Second we will work to develop a risk assessment framework for environmental monitoring datasets, focussing on both current risks to these datasets, and the extent to which they are important to delivering national-level reporting indicators such as the Natural Capital Asset Index (**Feb 2021**; intended audience: agencies, SG, SRP researchers; [Rob.Brooker@hutton.ac.uk](mailto:Rob.Brooker@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. These metrics have now been complemented by experimental studies to examine in more detail the role of woodlands with respect to their topographic position in the landscape. Results demonstrated the importance of riparian woodland buffers with an extent of c. 500 metres, in providing refugia for biodiversity under future climate change. This is being prepared as a series of recommendations for landowners contributing to the Atlantic Woodland Alliance, to protect and expand Scotland's rainforest (**Oct 2020**; 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 2021**; audience: SG, NGOs, agencies; [Colin.McInnes@moredun.ac.uk](mailto:Colin.McInnes@moredun.ac.uk)).

We continue to work with the local SNH 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 (**Mar 2021**; audience: SG, agencies, NGOs, land managers, farmers; [Philip.Skuce@moredun.ac.uk](mailto:Philip.Skuce@moredun.ac.uk)).

**System – including ecosystem – resilience** (1.3.3, O1 and O3) is an emerging focus for research and policy. Our current activities build on foundation work undertaken in 2016-19 including a focussed workshop run jointly with SNH to identify main gaps in knowledge of ecological resilience in Scotland's biodiversity and ecosystems (see [workshop report](#)). We are now specifically looking at the impact of multiple tree diseases on woodland biodiversity and assessing the diversity of tree species present within our woodlands and if they provide resilience (**Jan 2020**; audience: SG, agencies, NGOs, land managers; [Ruth.Mitchell@hutton.ac.uk](mailto:Ruth.Mitchell@hutton.ac.uk)).

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. Papers and research summaries are being prepared to share with stakeholders. A pilot study on the effect of summer drought has also highlighted differences in how provenances respond. Work is continuing in 2020-2021 to prepare stock for a large-scale frost tolerance experiment in spring 2021 (**Feb 2021**, 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 apply the species distribution model developed earlier to explore how land use change, using wood land expansion as an example, may affect the distribution of mountain hares. (**Mar 2021**; audience: SNH, National Park Authorities, NGOs, agencies; [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 is asking whether recently regenerated wood can be substituted for more ancient woodland. The initial phase of this work has characterised the chronosequence of sites enabling contrasts between stands of different age. Sites have also now been identified within which additional sampling can take place to understand the number and types of species that are absent from woodlands affected by negative pressures (**Dec 2020**; 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.

Case studies of **Natural Capital Accounting** (1.4.1, Oc) focusing 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 [summary](#) of survey rationale, methods, and results and planned future analysis is available. A case-study on urban green space is underway. This utilises both existing valuation data and a primary valuation study covering biodiversity and recreation. A poster on the impacts of greenspace on mental health was presented at the Ecosystem Services Partnership Conference, Hannover and further primary data are now being analysed. The urban greenspace accounts have been completed. Year 5 plans include developing marine natural capital accounts (**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 study to learn lessons from pilot approaches to using natural capital accounting processes for land-based businesses, working with University of Edinburgh, has been completed and a briefing on findings should be available in **November 2020**; with a potential webinar planned for early **December 2020** (Intended audience: Scottish Forum for Natural Capital Sustainable Land Use working group; [Kirsty.Blackstock@hutton.ac.uk](mailto:Kirsty.Blackstock@hutton.ac.uk)).

## SPOTLIGHT PRESENTATION

Research into the use of **Social Innovation** (1.4.2biii) to deliver multiple benefits is continuing. Barriers and opportunities for woodland expansion and green energy development are being investigated; findings communicated to SG agencies and cross-sector stakeholders at a workshop at Hutton and disseminated including via organised sessions at the 125 IUFRO Congress, the Forum Carpaticum, the ISIRC Conference, the ESG virtual event (**Sept 2020**). The journal articles produced included 7 published in a [special issue](#) of Forest Policy and Economics. This RESAS work was underpinned by H2020 SIMRA project that we coordinated (with the final conference held **Feb 2020**, Brussels). Innovative solutions and sustainable forestry considerations, ideas potentially useful for policy makers and practice communities of different levels have been elaborated, with some presented at the workshop of **Oct 2019** at Hutton (Intended audience: SG and wider stakeholders; [Maria.Nijnik@hutton.ac.uk](mailto:Maria.Nijnik@hutton.ac.uk)).

**Opportunities to increase multiple benefits through partnership working** (1.4.2bi). We are currently analysing data from selected four case studies in Scotland and England (Dee, Spey, Hampshire Avon and Poole Harbour) to consider how catchment partnerships combine public policy and private sector mechanisms to deliver multiple benefits (in conjunction with WP 1.2.4). An interim [report](#) is now available and a full report will be available (**Jan 2021**). Emerging themes have been used to comment on post-Brexit policy

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

The findings (from 1.4.2bi) referred to in the preceding paragraph was one of several projects from across the SRP summarised in a paper to the Scottish Land Commission (contact: Harriet Donald) as potential evidence for the four main questions being considered as advice to Ministers on setting up Regional Land Use Partnerships in **August 2020**. We will continue to share insights and provide support over the winter e.g. invited seminar in **November 2020** and will discuss further activity after the response from Ministers is received. This was the main request received for evidence to **support Post-EU environmental and agricultural policy (1.4.2bii)** (audience: SG and agencies; [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). Analysis will continue throughout 2020 including a Net-Zero scenario (**Mar 2021**; 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.

We are developing **land use change scenarios** (O1.4.2ciiD5) under climate change. The work so far has followed the SSP1 and SSP5 narratives adopted by IPCC as backdrop and adapted them to the Scottish case (in collaboration with the CEH SPEED project), and used an agent- Agent based modelling approach, to provide likely spatially explicit changes between 2020 and 2050. Land use change results for these 2 narratives have been produced and environmental consequences are being assessed, with focus on catchment-wide ecosystem services (nutrients and soil retention) and habitat connectivity. ([Alessandro.Gimona@hutton.ac.uk](mailto:Alessandro.Gimona@hutton.ac.uk)).

To understand the **range shifts and resilience of key pest species to climate change** we developed models and produced risk maps that predict the response to climate change of ticks and Lyme disease (the most prevalent vector-borne disease in the northern hemisphere)

(1.3.3, O2.2a). These were published for Scotland-wide predictions in 2016-17 in the *Journal of the Royal Society Interface* and for Europe-wide predictions in 2018-2019 in the journal *Environmental Health Perspectives* (Impact Factor 8.1). We are now conducting 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. (audience: SG, agencies, SNH, NHS, land managers, public; [Lucy.Gilbert@glasgow.ac.uk](mailto:Lucy.Gilbert@glasgow.ac.uk)).



**Photo:** Assessing which individual deer contribute most to the tick population.



**Photo:** Tick and Lyme Knowledge exchange at an orienteering event.

Peatland systems are a key component of the natural environment's contribution to

climate change mitigation. We have developed an initial local test model at high resolution of peatland restoration success for the area surrounding RSPB Forsinard using Sentinel-2 data, which we developed further (**Nov 2019**) and are currently continuing to test for a wider 100 km<sup>2</sup> regional area. Research findings to date were shared at the European Geoscience Union conference (**May 2020**) and a manuscript is in preparation. We are now also testing the model across multiple years to assess longer term stability of restoration success. A research note with our interim findings was prepared and 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)).



**Photo:** Formerly eroded and now restored peatland in the Cairngorms.

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 2018-2021 (**Mar 2021**; intended audience: SG and agencies involved in AECS implementation; [Robin.Pakeman@hutton.ac.uk](mailto:Robin.Pakeman@hutton.ac.uk)).

One farmland management action that will be investigated in detail is the **impact of liming** (1.3.1, O1.3b). In collaboration with RD 1.1.2 and RD 1.1.4 field level studies will be used to assess the effects of lime

application to extensively managed grassland on sward diversity and key invertebrates (earthworms) for breeding and over wintering waders. Over 2020-21 we will focus on analysing data to try to understand the effects of lime addition on soil characteristics, the abundance and biomass of earthworms, and vegetation community structure and productivity (**Mar 2021**; audience: SG, agencies, land managers; [Scott.Newey@hutton.ac.uk](mailto:Scott.Newey@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 continued monitoring the environmental benefits of 'magic-margins' that were implemented in collaboration with farmers on the Balruddery catchment in 2019. Magic margins are an innovative, award-winning agri-environment management option developed at the James Hutton Institute, as a measure to deliver multiple benefits associated with sediment loss, flood management, biodiversity conservation and associated ecosystem services (ESS), and the promotion of positive social benefits (cultural ESS) while restricting access in pursuit of illegal activities (e.g. hare coursing). The success of the establishment of the magic margins' measure at Balruddery will be assessed (**Dec 2020**) and their environmental performance will be assessed in 2021 / 2022. The investigation of potential agri-environmental scheme design and related payment to support the coordination of farmers' adoption of magic margins to deliver multiple benefits at the landscape scale is now scheduled for **Mar**

**2021** (audience: SG, land managers and advisors; [Laure.Kuhfuss@hutton.ac.uk](mailto:Laure.Kuhfuss@hutton.ac.uk)).

The investigation of mechanisms for the delivery of **multiple benefits through innovative and collective approaches to water management** (1.4.3d) has investigated a new case study in Loch Leven catchment for a comparative analysis. Our research has shown that Loch Leven shares similar characteristics with the Lunan catchment with inherited hydraulic structures and related governance that can impend adaptive management. We aim at investigating how governance rules can be best adapted to suit current multiple needs from evolving stakeholders and environmental needs on the catchments. Two more case studies will be investigated in 2020 with a full comparative analysis expected by **Mar 2021** (audience: agencies, local authorities; [Andy.Vinten@hutton.ac.uk](mailto:Andy.Vinten@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 plan to hold the workshops when feasible. The research on the participatory video been presented at numerous conferences and is being written up into a paper for a special issue of People and Nature by **Dec 2020**. The participatory videos and supplementary reports by school pupils and Neighbourhood Network Cumbernauld will be used as monitoring and evaluation baselines for the Creating Natural Connections project. The research on citizen social science approaches to monitoring impacts of management interventions has been completed and re-submitted for publication as scientific paper (**Oct 2020**; audience: land managers; [Antonia.Eastwood@hutton.ac.uk](mailto:Antonia.Eastwood@hutton.ac.uk)).

**Development of a user-friendly tool for visualising woodland expansion through Stereo panorama Images** (O1.4.2, Ocii). Virtual reality models have been created for the presentation of current woodland scenarios in the Cairngorms National Park. The Future woodland scenario has been presented in 3D Environment in Cairngorms National Park within preferred areas (Cairngorms National Park Forest

Strategy 2018). Afforestation animation has been attached in Google My Maps (video accessible [here](#)). Stereo-panorama images of woodland expansion scenarios have been created. They are available to be view from PCs, Mobile Devices and VR equipment. Results from woodland expansion scenarios were presented at EGU2020: Sharing Geoscience Online (**May 2020**; [Chen.Wang@hutton.ac.uk](mailto:Chen.Wang@hutton.ac.uk)).

The **impacts of tree pests and diseases** are being considered. In particular, the wider environmental risks from tree diseases. This work explores methods to link assessment of service provision by woodland habitats to assessment of priority habitats likely to be affected by tree diseases (1.3.3, O3.1a). We have developed a database of over 2000 species that are found on oak trees and included an assessment of if they will use any of 30 other alternative tree species. The information has been used to develop [30 case studies](#) across the UK to provide examples of how to manage oak woods to conserve oak-associated biodiversity in the face of a decline in the health of oak trees. Data from six sites across the UK has been collected to test the suitability of other tree species to replace oak in terms of biodiversity supported and ecosystem function the database is available [here](#) (**Dec 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). Digital storytelling (taking the form of short videos) is being used to gain a deeper understanding of the social issues associated with natural asset management, including reconciling

competing interests, strengthening collaboration between stakeholders, and reducing environmental conflict. The production of the digital stories that aim to deeply communicate multiple ways of storying actual and potential woodlands are nearing completion (**Jul 2020**). These will be embedded within an online mapping platform (**Sept 2020**) and will be explored and discussed in a stakeholder workshop with a view to co-creating more adaptive or collaborative ways of envisioning and planning for new and upland woodland (**Nov 2020**). Due to current social distancing requirements and the uncertainty that this creates for holding workshops, we are currently developing ways to use the digital story mapping technique to gain an understanding of people's interaction with their local woodlands during the lock down period. ([Katrina.Brown@hutton.ac.uk](mailto:Katrina.Brown@hutton.ac.uk)).

Approaches that reconcile woodland expansion with other land use priorities (1.4.3, Oc). 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 adaptive management for realising multiple land use benefits (under journal review **Oct 2020**). The research has now been expanded to include urban areas (Cumbernauld and Seven Lochs) as a comparison and data is currently being analysed (**Sept 2020**; audience: NGOs; stakeholders, policy makers; [Antonia.Eastwood@hutton.ac.uk](mailto:Antonia.Eastwood@hutton.ac.uk)).